

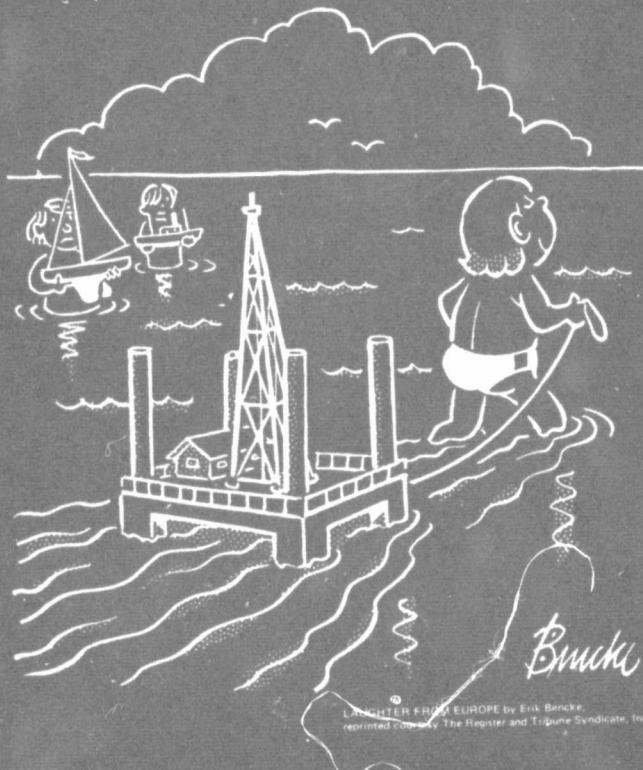
General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

PLANNING AND EVALUATION PARAMETERS FOR OFFSHORE COMPLEXES

Michael Z. Sincoff and Jarir S. Dajani,
Editors



LAUGHTER FROM EUROPE by Erik Bencke.
reprinted courtesy The Register and Tribune Syndicate, Inc.

NASA CR-145040

NASA 1976



NASA

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23685


OLD DOMINION
UNIVERSITY

N76-33084

Unclass

(NASA-CR-145040) PLANNING AND EVALUATION
PARAMETERS FOR OFFSHORE COMPLEXES (Old
Dominion Univ., Norfolk, Va.) 209 P HC
CSCL 13M G3/85 03497
\$7.75

Unclass

CSCl 13M

03497

1. Report No. NASA CR-145040	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle PLANNING AND EVALUATION PARAMETERS FOR OFFSHORE COMPLEXES			5. Report Date September 1976
			6. Performing Organization Code
7. Author(s) Michael Z. Sincoff and Jarir S. Dajani, Editors			8. Performing Organization Report No.
9. Performing Organization Name and Address Old Dominion University Norfolk, Virginia 23508			10. Work Unit No.
			11. Contract or Grant No. NGT 47-003-028
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546			13. Type of Report and Period Covered
			14. Sponsoring Agency Code
15. Supplementary Notes This document summarizes the results of the 1976 NASA-ASEE Summer Faculty Fellowship Program in Engineering Systems Design conducted at the NASA-Langley Research Center in Hampton, Virginia, during the period June 7 - August 20, 1976.			
16. Abstract <p>The report presents issues for consideration in the planning and design of offshore artificial complexes. It reviews issues dealing with the construction of such complexes, their social, economic, and ecological impacts, and the legal-political-institutional environments within which their development could occur. The report emphasizes planning, design, and construction of near-shore complexes located off the Mid-Atlantic coast of the United States. Although the report exemplifies complexes developed for the primary purpose of transportation, and secondary purpose of energy and other uses, its content is applicable to any offshore development. Some synergies among functions are also discussed.</p>			
17. Key Words (Suggested by Author(s)) (1) Artificial Islands; (2) Energy; (3) Engineering Systems Design; (4) Evaluation; (5) Offshore; (6) Planning; (7) Transportation		18. Distribution Statement Unclassified-Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 212	22. Price* \$7.25

THE AUTHORS:

**Michael Z. Sincoff, Ph.D., Project Director
Jarir S. Dajani, Ph.D., Assistant Director**

Lawrence S. Beckhouse, Ph.D.
Theodore M. Breu, Ph.D.
Eugene Chesson, Jr., Ph.D
Peter Cornillon, Ph.D.
Joseph E. Dandois, Ph.D.
Alvin James Darby, Ph.D.
Les Frair, Ph.D.
Michael Fulda, Ph.D.
Serge Gonzales, Ph.D.
Abe Kellizy, Ph.D.
Michael Kyong-il Kim, M.Arch.
Jeffrey A. King, B.S.
Joseph H. Marchal, Ph.D.
Stephen J. Mecca, Ph.D.
Blake D. Morant, B.A.
Vjekoslav Pavelic, Ph.D.
Newton Rose, Ph.D.
Jay R. Sculley, Ph.D.
Harvey B. Silverstein, Ph.D.
Donald E. Todd, Ph.D.

This report was compiled and written by the authors listed above, each of whom was a participant in the 1976 NASA-ASEE Summer Faculty Fellowship Program in Engineering Systems Design. The authors represented 22 different colleges and universities, and 17 different academic disciplines.

TABLE OF CONTENTS

	Page
List of Figures	vi
List of Tables.	vii
Foreword.	ix
Summary, Conclusions, and Recommendations	3
Introduction	3
Summary and Conclusions.	3
Recommendations.	6
Chapter I, Developmental Issues	11
Introduction	11
Functions and Impacts.	12
Structures	16
Types of Construction	17
Dike and Polder.	19
Dike and Fill.	21
Rigid Bottom-Based Structures.	23
Floating and Semi-Submersible.	23
Appraisal	25
Legal-Political Issues	27
International Law	27
Federal and State Jurisdictions	34
Environmental Legislation	35
National Environmental Policy Act of 1969.	35
Federal Water Pollution Control Act & Amendment of 1972	36
Marine Protection, Research, and Sanctuaries Act of 1972	37
Coastal Zone Management Act of 1972.	38
Clean Air Act and Amendments of 1970	38
Noise Control Act of 1972..	39
Fish and Wildlife Coordination Act	39
Federal Water Project Recreation Act	39
National Historic Preservation Act of 1966	39
Institutional Arrangements	39
The Effect of Location.	39
More Than 200 miles.	39
Between 3 and 200 miles.	40
Between 0 and 3 miles.	41
Ownership Alternatives.	41
Public Ownership	42
Private Ownership.	42
Mixed Public and Private Ownership	42
Financing	42
Summary.	45
End Notes.	45

	Page
Chapter II, Planning and Design	51
Introduction	51
The Process.	51
Variables in Planning	52
Generating Alternatives	54
Evaluation.	69
Synergistic Effects.	70
Temporal Evolution	73
End Notes.	74
Chapter III, Impact Assessment.	79
Introduction	79
Preliminary Socioeconomic Impact	79
Community Impacts.	82
Community Cohesion.	83
Community Facilities and Services	86
Political Impacts.	91
Demographic Impacts.	91
Economic Impacts	98
Business Activity and Employment.	98
Residential Activity.	101
Property Value and Taxes.	102
Regional and Community Plans.	104
Physical-Ecological-Impacts.	105
Physical-Ecological Considerations.	106
Prediction.	111
Current Impact-Assessment Methodologies	112
Quality of Life.	116
End Notes.	119
Chapter IV, Legal and Institutional Considerations.	125
Introduction	125
Legal Considerations	125
Applicable Laws	125
Future Laws	128
Regulation of the Complex	129
Specific Legal Problems of Offshore Complexes	131
Compensating Impacted Areas	131
Taxation.	132
Antitrust Problems.	133
State Controls.	134
Jurisdictional Problems	135
Environmental Legal Constraints.	136
Water Regulations	136
Air Regulations	142
Potential Litigation.	143
Institution Issues	145
Licensing Procedure	145
Departments.	145
Agencies	145

	Page
Topics	146
Necessity for New Laws.	149
Construction Time	150
Political Support	153
Deepwater Ports.	154
Airports	154
Energy Production.	154
Private Interests	155
Airlines	156
Oil Companies.	156
Electric Utilities	156
Political Characteristics.	157
Liability and Insurance.	157
Conclusions.	159
End Notes.	160
References.	167
Selected Bibliography	173
Appendixes	187
Appendix A: Faculty Fellows and Associates, NASA-ASEE Engineering Systems Design Program, Summer 1976	187
Appendix B: Guest Lecturers	193
Appendix C: Acknowledgements.	195
Appendix D: Organization of the Design Team	199
Appendix E: Selected Conversion Factors	201

LIST OF FIGURES

Figures		Page
CHAPTER I		
1-1	Representative Dike and Fill Island	20
1-2	Representative Dike and Polder Island	22
1-3	Typical Rigid Bottom-Based Structure.	24
1-4	A Floating and Semi-Submersible Structure	26
1-5	Ocean Zoning.	28
CHAPTER II		
2-1	Levels of the Planning Process.	53
2-2	Functional Analysis and the Generation of Planning Alternatives	68
2-3	General Functions for Offshore Complexes.	71
2-4	Temporal Evolution of Project Development	75
CHAPTER III		
3-1	Demographic Simulation Model Flowchart.	95
3-2	Physical-Ecological Impact Cycle.	110
3-3	Example of Matrix Methodology	115
3-4	Evaluation Sheet for the Highway Impact on the Quality of Life (QOL) of Various Population Segments.	118
CHAPTER IV		
4-1	Estimated Schedule for an Artificial Island	151

LIST OF TABLES

Table		Page
CHAPTER I		
I-I	Possible Island Functions	13
I-II	Estimates for Offshore Construction	18
I-III	Laws and Agencies Affecting Offshore Zones.	29
I-IV	Types of Potential Financing.	44
CHAPTER II		
II-I	A Morphological Listing of Design Variables.	55
II-II	A Morphological Listing of Contextual Variables	63
II-III	A Morphological Listing of Performance Variables.	65
II-IV	Types and Examples of Synergy	72
CHAPTER III		
III-I	Community Institutions: Baseline Descriptors	87
III-II	Scheme for Relevant Political Mapping (with Selected Examples).	92
III-III	Physical-Ecological Impact Considerations	108
CHAPTER IV		
IV-I	Approved East Coast Dumping Sites for Dredge or Fill Material . .	140
IV-II	Primary Agencies and Their Environmental Responsibilities . . .	147

FOREWORD

This document summarizes the results of the 1976 NASA-ASEE Summer Faculty Program in Engineering Systems Design conducted at the NASA-Langley Research Center in Hampton, Virginia, during the period June 7 through August 20. The program was sponsored jointly by the National Aeronautics and Space Administration and the American Society for Engineering Education through a contract by NASA (NGT 47-003-028) to the Old Dominion University Research Foundation of Old Dominion University.

Included among the objectives of this program were to: (1) provide a framework for communication and collaboration between academic personnel, research engineers, and scientists in governmental agencies and private industry; (2) provide a useful study of a broadly-based societal problem requiring the coordinated efforts of a multidisciplinary team; and, (3) generate participant experience in, and foster interest toward, the development of systems design activities and multidisciplinary programs at the participants' home institutions.

These three objectives were met through a study of offshore artificial island complexes, characterized by intensive scrutiny of many ideas, philosophies, and academic perspectives on this multidimensional problem. To assure awareness and testing of many points of view, and to achieve some convergence of best ideas, a group of 22 investigators was assembled. The design team represented 22 different colleges and universities, and 17 different academic disciplines--architecture, civil engineering, economics, electrical engineering, engineering management, environmental engineering, geography, geology, industrial engineering, international studies, law, mechanical engineering, operations research, organizational communication, philosophy, physics and sociology.

Although the presence of a multidisciplinary team has been essential to the success of this study, the program itself has been enhanced by guest lecturers and consultants (see Appendixes B and C). Additionally, particular appreciation is expressed for the administrative support provided by the Co-Directors of the NASA-ASEE Summer Institutes, Dr. John E. Duberg of NASA-Langley, and Dr. G.L. Goglia of Old Dominion University. The assistance of Mr. John Witherspoon and Mr. Malcolm P. Clark, both of the NASA-Langley Personnel Training and Educational Services Branch, Personnel Division, was indispensable to the functioning of the program.

Dr. Wayne D. Erickson of NASA-Langley served as technical advisor to the Design Team from its inception to its conclusion. For his assistance, the participants express appreciation.

Michael Z. Sincoff, Project Director
Jarir S. Dajani, Assistant Project Director

August 20, 1976

PRECEDING PAGE BLANK NOT FILMED

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

INTRODUCTION

Primary considerations of this report are directed toward the development of a general methodology that may be useful in planning and construction of offshore artificial island complexes. Although emphasis has been placed on transportation/energy uses for the region off the Mid-Atlantic Coast of the United States, the guidelines presented and issues addressed are applicable to other large-scale projects in other locations.

SUMMARY AND CONCLUSIONS

In order for the United States to maintain its leadership role while meeting the changing needs of the future, alternative sources of food and energy as well as new sites for industrial and commercial development are necessary. Traditionally, changes to satisfy needs have considered primarily the constraints of capital, labor, and technology. Future projects will need to consider both constraints and impacts on the environment, and effects on the social system.

An offshore complex could be used to relieve some of the current and projected transportation/energy needs for the Mid-Atlantic Region of the United States. Other offshore complex uses should be considered for their synergistic interactions with transportation and energy.

An offshore complex can be built using one of four basic types of construction: (1) dike and polder; (2) dike and fill; (3) rigid structure; and, (4) floating or semi-submersible. Construction cost is site-dependent and increases somewhat exponentially in the order of island type listed above. Current (1976) costs for construction could range from \$10,000 to \$600,000,000 per square hectometre.

Planning and design considerations for an offshore complex are numerous, usually interdependent by nature, often subjective, and thus difficult to evaluate. The design process involves the identification of need, the generation of alternatives, and evaluation. In planning for an offshore complex, the number and extent of interactions with different levels of government and their

regulatory agencies will usually increase as the site selected becomes more specific.

Variables to be considered in planning and design can be categorized as contextual, design, or performance. One systematic methodology for generating alternatives is the morphological approach which produces an extensive list of alternative elemental building blocks. Such lists are useful in producing innovative and creative concepts of design. The evaluation of alternatives depends on the value system established.

The design of an offshore complex should consider activities which produce some measure of synergy with other complementary activities. Offshore complex activities which are compatible with the environment should be sought with vigor.

Impact assessment attempts to deal with modifications, which an offshore island complex is expected to make on both the environment and various socio-economic systems. The strategy to be followed in preparing such assessments includes: (1) determination of impact variables; (2) collection of baseline data; (3) projections from the baseline situation; (4) comparisons between the baseline situation and projections; and, (5) evaluation of the resulting differences or impacts.

A physical-ecological impact assessment attempts to predict changes that may occur in the natural environment during the construction and operation stages of a project. In the case of an offshore complex, these changes may take place in the waters surrounding the complex, along the coastline adjacent to it and contiguous to the land-based support facilities. Estimates of changes affecting the baseline state of various physical-chemical-biological variables, must be made to assess these impacts.

The strategy used in the prediction of possible physical-ecological impacts begins with a list of those variables which are thought to be vulnerable to change. Baseline data on these variables are collected in the field or generated by specific studies. Projections are made of the baseline data to some specific future time. Projections are also made about the outputs of the complex during its construction and operations stages. Finally, comparisons are made between the "complex-built" and "no-complex-built" situations. The difference with regard to the variables selected in these two situations then con-

stitutes the impact.

Socioeconomic impact assessments attempt to identify social, political, demographic, and economic parameters likely to be affected by the development of an offshore complex. Such parameters can be identified and methods for assessing their impact can be delineated. These assessments may be quantitative or qualitative in nature. Social impacts that affect community cohesion and community facilities and services may occur as a result of an offshore complex. Indices, assessing such impacts, can be identified and examined. Demographic and political impacts and their relationship to social and economic considerations should be studied in detail. Methodologies using simulation models can be applied in evaluating demographic effects. Economic impact assessments consider business activity and employment, residential activity, property values and taxes, regional/community plans and growth.

Finally, evaluation criteria are applied to assess whether both physical-ecological and socioeconomic impacts fall within acceptable limits. If unacceptable, re-design of those components of the project responsible for negative impacts and other harm minimization measures must be found. The tradeoffs between the benefits to be derived from the complex and the uncontrollable negative effects must then be analyzed in order to make the final judgment as to the desirability of offshore complex construction. Many evaluation criteria remain largely subjective and open to pressures from the political, social, and economic sectors. In need of more refinement is the translation of physical-ecological impacts into socioeconomic terms in order to give more meaning to these evaluation criteria.

Presently, construction of an offshore complex by private enterprise without substantial public assistance appears unlikely. A review of possible public and private support for governmental assistance for the construction of an offshore complex reveals a large degree of fragmentation. Most of the groups reviewed have some interest in the complex, but that interest varies with time. No single group has either the adequate combination of interest in the project or the financial and/or political power to serve as the prime mover and coordinator.

Applicable laws include international, federal, state, or local. Some apply to specific uses, while others are generally applicable to any type of offshore complex. Many of these laws overlap, cross jurisdictional lines, or

are applicable only within specified distances from shore.

Regulation of the offshore complex can be accomplished by a permit process which can be controlled by one agency, or by many agencies, provided a machinery is established to resolve inter-agency disputes. Since there is scant legal precedent for large-scale offshore complexes in the Mid-Atlantic Region, many specified legal problems remain unresolved. Examples are jurisdiction, antitrust and methods of taxation. The primary laws which apply to offshore facilities include regulation of water, air, and the seafloor.

The establishment of an offshore complex requires implementation of numerous rules, statutes, and regulations. Laws currently apply only to certain types of offshore complexes, and potential legal actions by citizens and groups will constrain the use and location of such a facility. Insurance liability for the artificial structure itself is not a well-defined area and needs clarification in future legislation.

RECOMMENDATIONS

- (1) When considering a project like an offshore complex, an early evaluation of the entire project and its impacts should be made.
- (2) Impact assessments should include social, economic, and political considerations in addition to physical-ecological factors.
- (3) Research should develop methodologies for conducting social, economic, and political assessment that include improved data collection techniques and evaluation criteria.
- (4) Efforts to involve the public with the formation of concepts and uses of offshore complexes should be undertaken.
- (5) Complementary activities that lead to synergies should be generated and considered to improve the system-wide utility of an offshore complex.
- (6) Methods of stimulating private investment in offshore complexes should be investigated. Reducing tax rates for offshore development and the pre-development issuance of a binding opinion by the Attorney General of the United States with respect to antitrust and other laws would be helpful.
- (7) Liability limits should be defined in areas relating to offshore complexes. The desirability of a liability fund to be set up by industry with possible participation by the government should be considered.
- (8) The insurability of an offshore complex should be explored. It may be necessary to pool resources in order to distribute the burden and benefits of such an undertaking.
- (9) Territorial boundaries should be defined more clearly and agreed upon at international, state, and local levels of government in order to promote the use of offshore complexes.

- (10) Machinery should be established for resolving inter-state as well as inter-agency disputes over areas of conflict caused by the development of offshore complexes.
- (11) A federal act specifically designed to authorize, coordinate, and regulate offshore complexes should be enacted. Although existing laws would probably provide an adequate foundation, an "Island Law" is desirable.
- (12) Permits, licenses, certifications, and approvals for offshore complexes should be coordinated by a single agency.
- (13) States, municipalities, and individuals should receive adequate compensation for costs, not otherwise recoverable, arising from the development of an offshore complex.

CHAPTER I

DEVELOPMENTAL ISSUES

Chapter I

DEVELOPMENTAL ISSUES

INTRODUCTION

Utilization of the world's oceans is seen as a possible answer to some of the difficult problems facing mankind today: the pressing need for increased imports of energy, the need for space, for industrial and community development, looming food shortages, and environmental degradation on land.

With coastlines of the more urbanized areas of the industrialized world already crowded with refineries, factories, and warehouses, and the growing public insistence on preservation of remaining wetlands, the construction of artificial offshore island complexes is seen as a means of relieving congestion on land and of preserving the estuarine and nearshore environments. A number of studies have been conducted during the past few years, addressing the concept of utilizing offshore ocean space for the provision of a variety of functions.¹

Although this report may be of interest to many individuals representing all levels of public and private agencies, it will be of greatest benefit to those who are planning and evaluating major offshore and nearshore ocean-based projects located off the Mid-Atlantic Coast of the United States and extending from Cape Cod south to Cape Hatteras. While emphasis has been given to a transportation/energy complex, the methodology used and many of the specific considerations provided will be applicable to major projects of all types, whether single- or multi-purpose.

Selected portions may assist top decision-makers, legislators, agency heads, and corporate leaders. The bulk of the report will be of value to those who are involved with the staff and support functions of designing, planning, and evaluating offshore and nearshore projects: engineers, scientists, planners, environmentalists, who will be responsible for insuring that a design can be justified technically, economically, socially, politically, and environmentally.

The following sections provide a brief orientation about offshore artificial island complex functions and impacts, structures, legal-political issues, and institutional arrangements.

FUNCTIONS AND IMPACTS

Various primary functions can be identified as having viability either for a single-use offshore system or as part of a multiple-use complex. Table I-I is a thorough, but non-exhaustive list of possible island functions.

In order to obtain a set or sets of integrated functions, which can be meaningfully provided in a single offshore complex, an analysis of the inputs and outputs of each individual function must be undertaken. Inputs include materials, information, space, structures, energy, capital, and labor. Outputs include both useful and waste products. Different functions must be analyzed with respect to their compatibility, as well as to the potential positive and negative synergistic effects which may influence the productivity and impact of the processes involved.

Factors such as indices allowing the relative ranking of the different activities in accordance with their environmental requirements, anticipated international and national need, and perceived land siting problems should be considered. Other evaluation parameters include the appropriateness of the ocean environment for each of the proposed activities, labor intensity (personnel required) of the activity, environmental disruptivity to ocean and shore areas, locational value (sources) of inputs, locational value (destinations) of outputs, and energy intensity (power demands of the island activity). Based on a review of the literature and a subsequent evaluation analysis covering the general indices and parameters discussed above, it was the opinion of the authors that the ten categories of possible functional uses (exclusive of "Other") for the United States Mid-Atlantic Coast can be classified into three sub-categories, as follows:

- 1) High relative potential: transportation, energy
- 2) Medium relative potential: military, science and engineering, communication
- 3) Low relative potential: industry, housing, recreation, and mariculture.

TABLE I-I
POSSIBLE ISLAND FUNCTIONS

<p>1. Transportation (uses and modes)</p> <p>Air Landing facility Port facility Material transfer point (air land-sea interface) Pipeline terminal Utility tunnel (rail, pipe, cable, etc.) Floating island as transport vehicle Space-launching pad Transport service facility Rescue operations base Combined mode transport management Hovercraft Helicopter</p> <p>2. Energy</p> <p>Ocean gradient Wave energy Tidal Solar Satellite beamed microwave Wind Nuclear fission Underwater currents Fusion Sewage waste conversion Hydrogen generation LNG use and conversion Oil exploration, drilling, production Storage and transfer Coal gasification Ocean organic material Geothermal Iceberg</p>	<p>Direct cooling and heating (via ocean water) Pumped water storage</p> <p>3. Communications</p> <p>Underwater communication Satellite communication Sound Navigational aid, weather with land environmental information Ship-aircraft communication Management coordinate center Communications relay Communications jamming Observation/surveillance Laser microwave modes Air-sea-satellite tracing</p> <p>4. Science-Engineering Research</p> <p>Nuclear particle accelerator Materials testing Marine institute Astronomical observatory Weather research Wildlife Waste research Satellite tracking Space recovery operation Coastal environmental study Ocean and subsea construction Sea beds research</p>
---	--

TABLE I-I (Continued)
POSSIBLE ISLAND FUNCTIONS

<p>5. Mariculture (farming and harvesting)</p> <ul style="list-style-type: none"> Food and non-food Plankton Shellfish 	<ul style="list-style-type: none"> Gambling Aquapark Boat racing Olympic site
<p>6. Industry</p> <ul style="list-style-type: none"> Metallurgical (Fe, Al, etc.) Glass industry Petrochemical complexes Ocean mineral extraction Liquified gas production (N, H₂, O₂, Cl) Forest (paper, wood, etc.) Waste management Ship construction (platform, assembly) Manufacturing requiring high pressures (deep ocean) Aquaculture manufacturing Materials testing Clean room (sound, light, etc.) Fresh water Offshore structures (Servicing, etc.) Warehousing and storage Food processing 	<p>8. Military</p> <ul style="list-style-type: none"> Airfield Storage Training Tactical weapons Electronic counter measures (surveillance, detection, etc.) Secure environment Launch platform (missiles) Dry dock for ship repair Rescue Testing Monitor extended domain Controlled rest and relaxation center
<p>7. Recreation</p> <ul style="list-style-type: none"> Fishing Diving Smallcraft (sailing, boating, skiing, etc.) Swimming Surfing Surface sports Hang gliding 	<p>9. Housing</p> <ul style="list-style-type: none"> Boat hotel Hotel Resort Apartment Condominium <p>10. Other</p> <ul style="list-style-type: none"> Penal colony Luxury, resort use Hospital (physical, mental) Retirement community Schools Customs Other community support activities

This categorization has led to the conclusion that transportation and energy uses, in that order, should be of primary national concern in the development of future offshore complexes for the Mid-Atlantic Coast. Other uses could be developed in conjunction with these primary uses to the extent feasible.

There are both legal and humanitarian reasons for including a detailed socio-economic and physical-ecological assessment of the impacts of a proposal to construct an offshore island complex. The building of a large housing project, bridge, interstate highway, or offshore island complex is certain to have an impact on the pre-existing demographic character of the immediate and surrounding areas. In the case of an offshore island, the impact will fall on that part of the mainland which is selected as the site for the construction-storage base or as the site for permanent support facilities.

In the pre-construction stage large numbers of people may have to be relocated from the selected mainland area. During the construction stage, which could take as long as a decade, workers and their families may have to be housed, fed, schooled, and entertained. Following construction many of these people will leave the region, while others will elect to stay, and seek new employment. A new group of people may move into the region during the operations stage. Finally, in the distant future, say 50 years, some decision will have to be made concerning the second generation use of the island (or its destruction); this last phase also will have an impact on the population of the area.

Social impacts which should be considered in examining the consequences of offshore island complexes include their potential effects on: (1) community stability and cohesion; (2) the accessibility of facilities and services for residents onshore, as well as for workers on the island; (3) influences on the relationships among residents and community institutions (e.g., the school system, religion, law enforcement, public welfare, and political participation); (4) local leisure time and recreational facilities and activities; and, (5) other cultural and aesthetic activities.

Some assessment of the economic impacts of an offshore transportation/energy island complex is necessary in the planning stages of such a project. This initial assessment will facilitate early determination of important types

of economic impact variables. Such information may be utilized in designing extensive data collection methods for the more pertinent economic variables. Changes in such economic variables as employment, income, tax base, business activity, and the like must also be considered in the design, construction, and operation of any proposed offshore complex.

The physical-ecological impacts of such large-scale construction must also be considered. These include the impacts on the natural ocean environment: air, water, and living organisms. They also include onshore effects resulting from induced changes in wave intensity and pattern. Detailed studies must be made in an attempt to minimize the extent of irreversible changes to both the ocean and land environments with special attention being paid to preservation of delicate coastal wetlands.

STRUCTURES

In reviewing available literature on the subject of offshore artificial islands, one fact is apparent: there are relatively few references available concerned either with a completely integrated industrial offshore community or with a multiple use facility. Most proposals or reports deal with a specific "single-use" facility (e.g., an offshore airport or an offshore power plant) rather than multi-use or multi-function offshore industrial community complexes.

The various reports and studies reviewed can be classified by their different applications or uses as follows:

- (1) Offshore Airports
- (2) Deepwater Seaport (superports)
- (3) Offshore Nuclear Power Plants
- (4) Multi-purpose Industrial/Port Islands
- (5) Offshore Oil Platforms
- (6) Offshore Conventional Power Plants
- (7) Solar, Thermal, Wind Power Plants
- (8) Dikes and Land Recovery (sea island or land extension)

The available literature could be divided also on the basis of the type of structures, rather than by use (e.g., dike and polder, dike and fill, rigid structure, and floating structure).

Types of Construction

When considering the type of construction or structure for an artificial island or complex, several factors must be weighed and the appropriate trade-offs or compromises selected. Construction method or island type is affected by:

- (1) activities planned for the island: these constrain the general location, water depth, exposure to wind, wave, and seismic activity, and access modes;
- (2) size: which may be determined by primary activities only, by secondary (supporting or synergistic) activities, or by economies in the scale of project--the ease of future expansion also may be a consideration;
- (3) cost: initial outlay and the annual or periodic (maintenance) expense must be considered; and,
- (4) life: some deterioration of all structural types is probable even with regular maintenance, and will affect selection of an island type or alter the economic justification.

Of course, there are other factors which must be considered as well: for example, environmental, including offshore and onshore; sub-surface, surface, and air; market and labor sources; and navigational.

Because of the multiple factors to be incorporated, the choice of construction method may be aided by the comparison of in-place costs presented in Table I-II. These estimates do not include access costs or capital investment for items such as industries, buildings, or tank farms. These are estimates only for "real estate" costs. The ranges of costs in Table I-II are quite wide yet they have general utility when tempered by these factors:

- (1) Water depths, bottom conditions, wind, wave, ice, and seismic factors varied from site to site and kinds of structure.
- (2) Costs quoted in articles were not always clearly those providing the "real estate." Some omitted placement or construction at the site, mooring, etc.; others included costs of power, water supply, environmental, and/or operational and production capital outlays.

TABLE I-II
ESTIMATES FOR OFFSHORE CONSTRUCTION
(Does not include access or industrial facilities)

Type System	Typical Water Depths m	Approximate Costs (Ranges) Per hm ² of Proj. Surface in \$1 x 10 ⁶		Estimated Life in Years	Estimated Annual Maintenance, % of Original Cost
		1976	1986**		
Dike & Polder	0 - 20	0.01-0.20	0.025-0.50	50 - 100	2 - 5%
Dike & Fill	0 - 30	0.35-1.25	1.0 - 3.25	50 - 100	1 - 2%
Rigid Structure Piles	0 - 90	1.80-18	5.0-50.0	25 - 50	5 - 10%
Jack-Up	90 -150	25.0 -	60.0 -	20 - 25	5 - 10%
Tower (Steel)	30 -250	250	600	20 - 30	5 - 10%
Pedestal (Concrete)	100 -300			25 - 40	- 5%
Floating Structure*					
Tensioned to Base Structure	300 -600			20 - 30	
Moored to Anchors	150-6000	15.0 -	40.0 -	20 - 40	5 - 15%
Automatic Station-Keeping	300 +	600	1600.0	20 - 25	
Platform up to 400 x 400 and floating (moored)	15 -300	6.0 -	16.0 -	20 - 40	5 - 10%
*Semi-submersible for most cases			**Assumes 10% escalation per year.		

Sources:

The information has been distilled from many reports, publications and articles from 1931 to 1976 and various cost estimates and contract amounts have been adjusted to 1976 dollars by use of the Engineering News Record Construction Cost Indices for the appropriate years.

(3) The Engineering News Record Indices were not intended for marine construction and were not intended for structures of significantly large sizes.

(4) Rigid or floating structures usually have multiple decks and/or compartmentation which provide "additional" usable area.

(5) Costs will be affected by size of project and number of projects (units or modules) to be built, since there are mobilization costs (and demobilization costs) which may be independent of the size of the project, or which may justify special equipment or facilities for a large job (or multiple sites) and which are uneconomical for small contracts.

In much the same manner, the typical water depths, estimated life, and annual maintenance estimates must be tempered by factors such as exposure, actual effects of storms, and possible collisions (if any), and the amounts initially invested in protection and construction quality.

Since any offshore construction project will require several years for planning and obtaining permits as well as additional years of fabrication and installation, figures such as those in Table I-II must be adjusted for probable inflation. Final costs may be at least 2 to 3 times those for 1976.

There are advantages and disadvantages in using the several types of construction for artificial islands. Some of the more important factors are outlined in the paragraphs below.

Dike and Polder. While restricted to relatively shallow water depths, dike and polder is often the least costly method to create space (Figure 1-1). Because the dike is the primary cost, the larger an area enclosed and the more nearly circular the dike, the smaller the cost per unit of area. The height of the dike depends on the depth of water, wave, and wind and the cost is approximately in proportion to the square of the dike height.

The availability and type of material used for the core, dike, armor, toe protection, and sea wall, (if any) will affect cost. If dredges are used, their size, type, and ability to operate in normal and heavy seas will be factors. Bottom composition and topography will affect the need for fill and grading, the ability to support a dike with a given side slope, and the need for toe protection. Permeability of the bottom will affect the initial

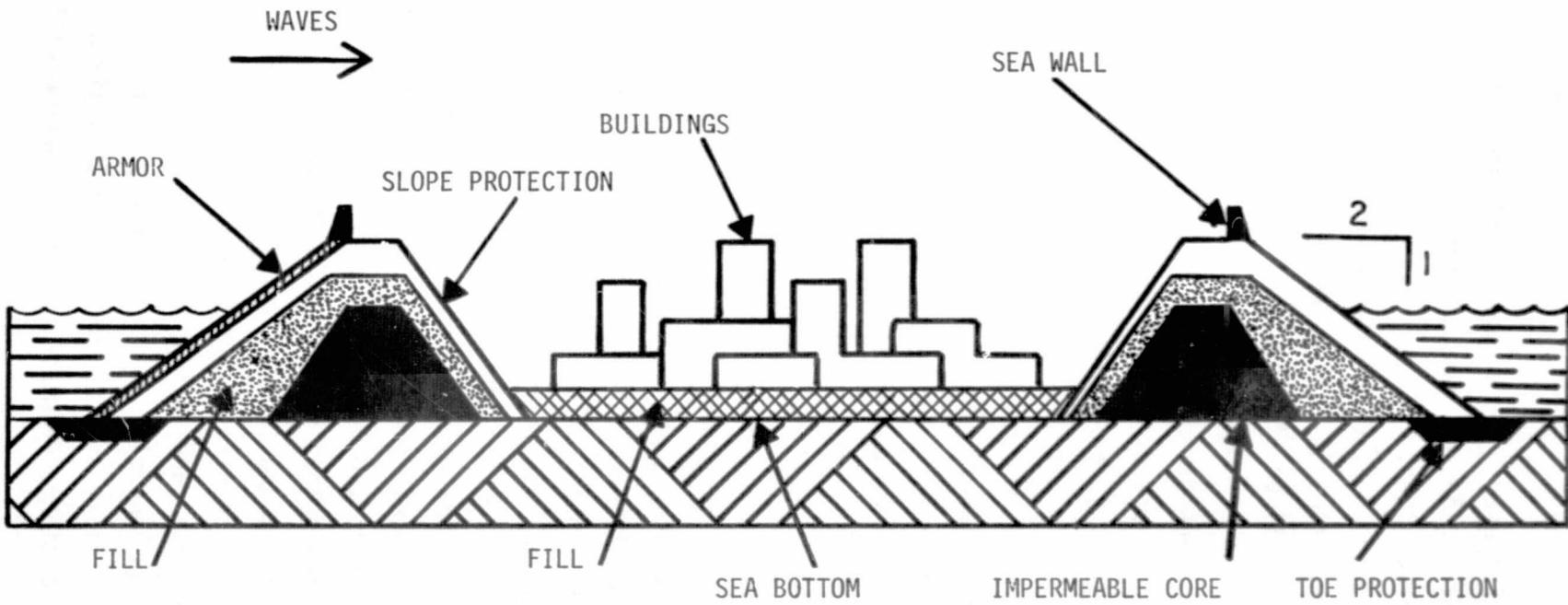


FIGURE 1-1
REPRESENTATIVE DIKE AND FILL ISLAND

SOURCE: Adapted from Multi-Purpose, Offshore Industrial Port Islands, College of Marine Studies, University of Delaware, Newark, Delaware, 1974.

and long-term pumping to keep the polder dry, to prevent "boils," and the need for sheet pile or grout curtains. Permanent pumping will be required for seepage, rainfall, and discharge of any treated wastes, since any "new land" will be below mean low water.

This method of construction may be especially sensitive to calamities since any major damage to the dike could flood the entire facility unless partition dikes were installed within the polder (thereby increasing the land costs). Dike damage causing flooding might occur from earthquake, explosion, collision, from a large vessel, sabotage, etc. Regular inspection and adequate maintenance is especially critical; when this is provided properly, there should be good life expectancy. Emergency evacuation of personnel would need to be planned and possibly practiced at suitable intervals. Because the floor of the polder will be 15-45 metres below the deck of cargo vessels, it may not be best suited as a shipping terminal (piers would be at different elevations than adjacent polder areas).

Costs of dike and polder construction are relatively unaffected by the planned use, and later conversion of the space to other uses is possible without expensive alteration. Since the construction will involve a substantial area in moderate water depths, the local environment and sediment transport will be altered. Any approach channels will probably need to be maintained by dredging. All-weather access by bridge, causeway, or tunnel may be possible along with surface (boat or ship) and air transport.

Dike and Fill. Many of the points presented for dike and polder construction apply to dike and fill (Figure 1-2). The cost per unit of area for dike and fill is dependent on both the length of dike and the cost of fill; as a result, the cost per unit of area for dike and fill is less sensitive to changes in the length of the dike than in the cost of dike and polder. The dike height affects costs approximately as the square of the height, but the fill cost per unit of area varies linearly with depth of fill (often 5 metres more above mean low water). Of course waves and winds affect the cost as does the availability of suitable material for the dike and for fill. The fill may include inert solid waste from municipalities (e.g., construction debris). Caissons may be used in the area of piers and to gain an initial "foothold" for construction; these might be constructed at a shoreline and towed to their positions where they could be sunk.

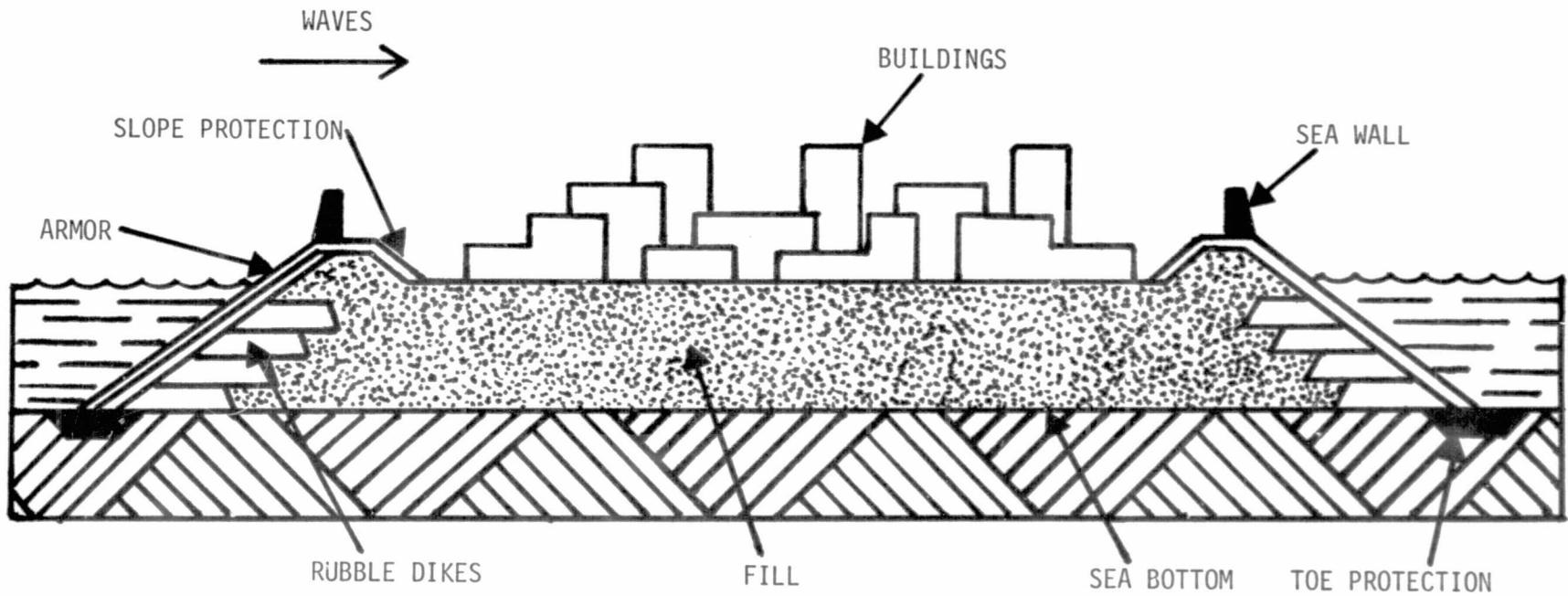


FIGURE 1-2
REPRESENTATIVE DIKE AND POLDER ISLAND

SOURCE: Adapted from Multi-Purpose, Offshore Industrial Port Islands, College of Marine Studies, University of Delaware, Newark, Delaware, 1974.

Bottom topography and strength are factors, but depending on bottom conditions, topography, and geology, the dike and fill island may be less affected by earthquakes than any other type of artificial island except floating. This type of "real estate" construction is relatively safe from the effects of collision, explosion, or fire. The pier and dock areas can be protected by breakwaters and by proper design for the harbor configuration. While inspection and maintenance are important, they are not critical to the same degree as for other construction types and the costs of repairs will be reasonable.

Costs per unit of area are relatively unaffected by use, and space may be converted easily if initial tenants relocate. Additional area can be developed by extension of diked regions plus fill. All-weather access by bridge, causeway, or more probably tunnel, is possible at a number of sites.

At the outset, substantial ocean ecological impact will result. Careful study may minimize effects on coastal configurations although some sediment deposition, especially in dredge channels, can be expected.

Rigid Bottom-Based Structures. Rigid structure costs are quite sensitive to wave, bottom conditions, and uses intended (Figure 1-3). The cost per unit of area probably will decrease as the total surface area is increased because of repetition (modular construction) and improved structural stiffness. The multilevel construction will provide some "free area."

These units are usually of steel construction, of reinforced concrete, or of post-tensioned or prestressed concrete. Costs are affected by the nature of the structural system: free-standing, jack-up, or cabled guyed. Inspection of any of these rigid structures is critical and costly; repairs are often difficult. Life expectancy is short compared to either dike method. These units are subject to critical damage by collision from aircraft, ships (including submarines) and by fire, explosion, and sabotage.

Construction logistics may be difficult because of the sizes and weights involved; however, ocean ecology and littoral drift are only slightly affected. Access (except for pipelines) is by water or air so that all-weather travel is not assured; and, as for the polder, rescue procedures should be considered.

Floating and Semi-Submersible. Floating and semi-submersible units are quite sensitive in cost to wind and wave effects but are relatively immune to earthquakes. These units are vulnerable to fire, aircraft or ship collision,

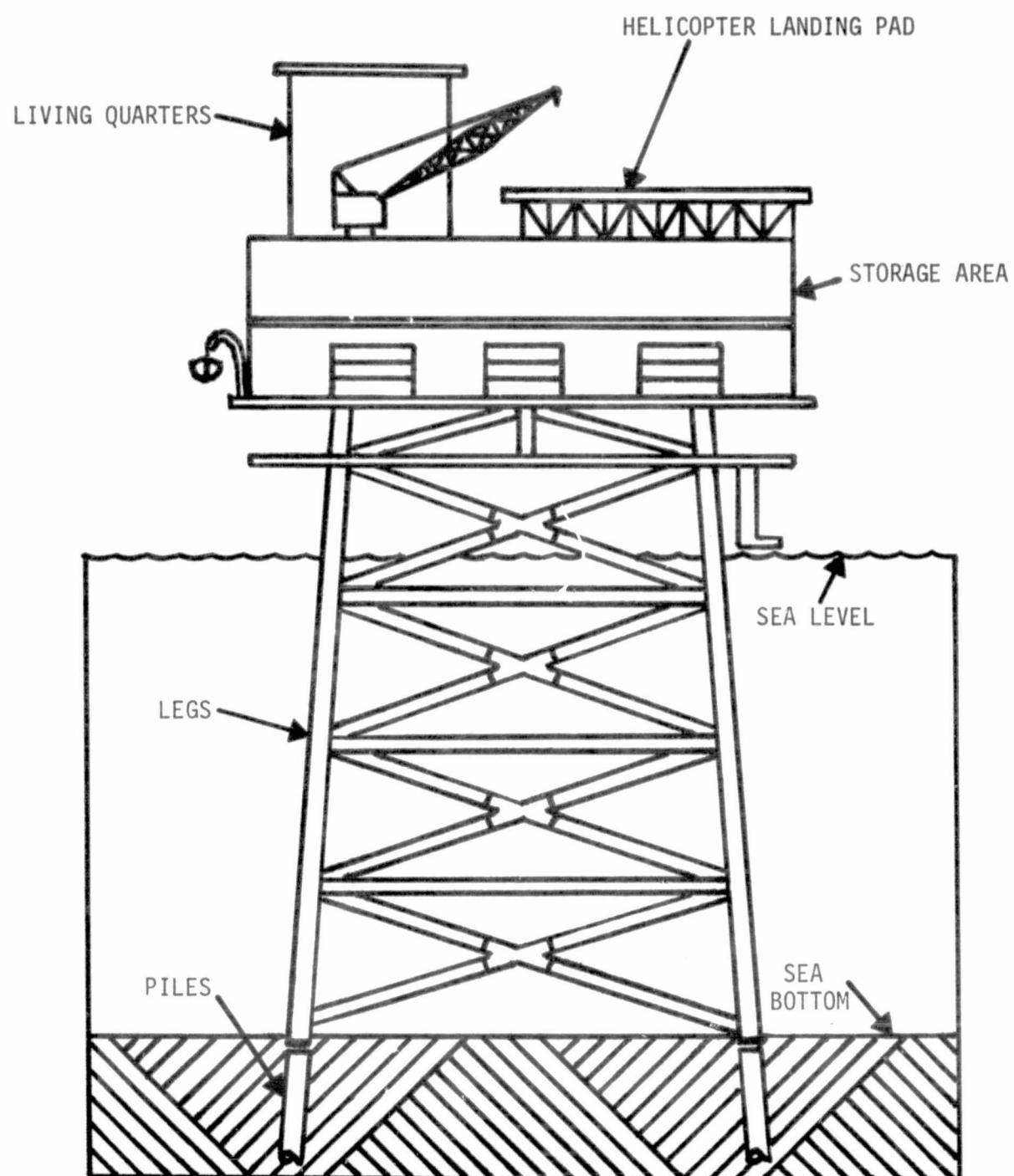


FIGURE I-3
TYPICAL RIGID BOTTOM-BASED STRUCTURE

explosion, and sabotage. A representative floating structure is shown in Figure 1-4.

While these structural systems are least affected by, and least affect, the ocean bottom ecology or strength, there are some systems which use large bottom construction for both storage (fluid) and mooring. Floating and semi-submersible structures can be repositioned if necessary. They are difficult to construct and to maintain and may be expected to have a relatively short life. Moorings and hulls need regular inspection.

The cost per unit area may be reduced somewhat as size is increased. Because of multi-levels and compartmentation, there is considerable "free" area. Deck stability in certain weather and ocean conditions may affect operations (e.g., ship unloadings, aircraft landings). Gravity flow systems may be affected and liquid "sloshing" may require care in design of utilities piping, and tanks.

While all-weather access may not be possible, they can be used in almost all water depths with mooring and/or automatic station-keeping equipment. Rescue procedures would need consideration. Because of portability, the matter of piracy may warrant review.

In none of the above four types of construction has the discussion been exhaustive. The matter of self-sufficiency for power, water supply, and waste-water treatment can be factors in the selection of construction methods. And, for almost any island purposes, the matter of insurance will need consideration and will vary widely depending on such factors as the structural type, use, and the number of workers and transients on the island.

Appraisal

(1) It is presently feasible to build offshore facilities either as dike and polder, dike and fill, rigid, or floating structures. The feasibility is proven by the existence of some such structures today for example, oil rigs in the Gulf of Mexico and the dikes in The Netherlands.

(2) Economics will be a major factor in the design and construction of an artificial island, not just initial design and construction cost, but also estimated life and estimated annual maintenance costs.

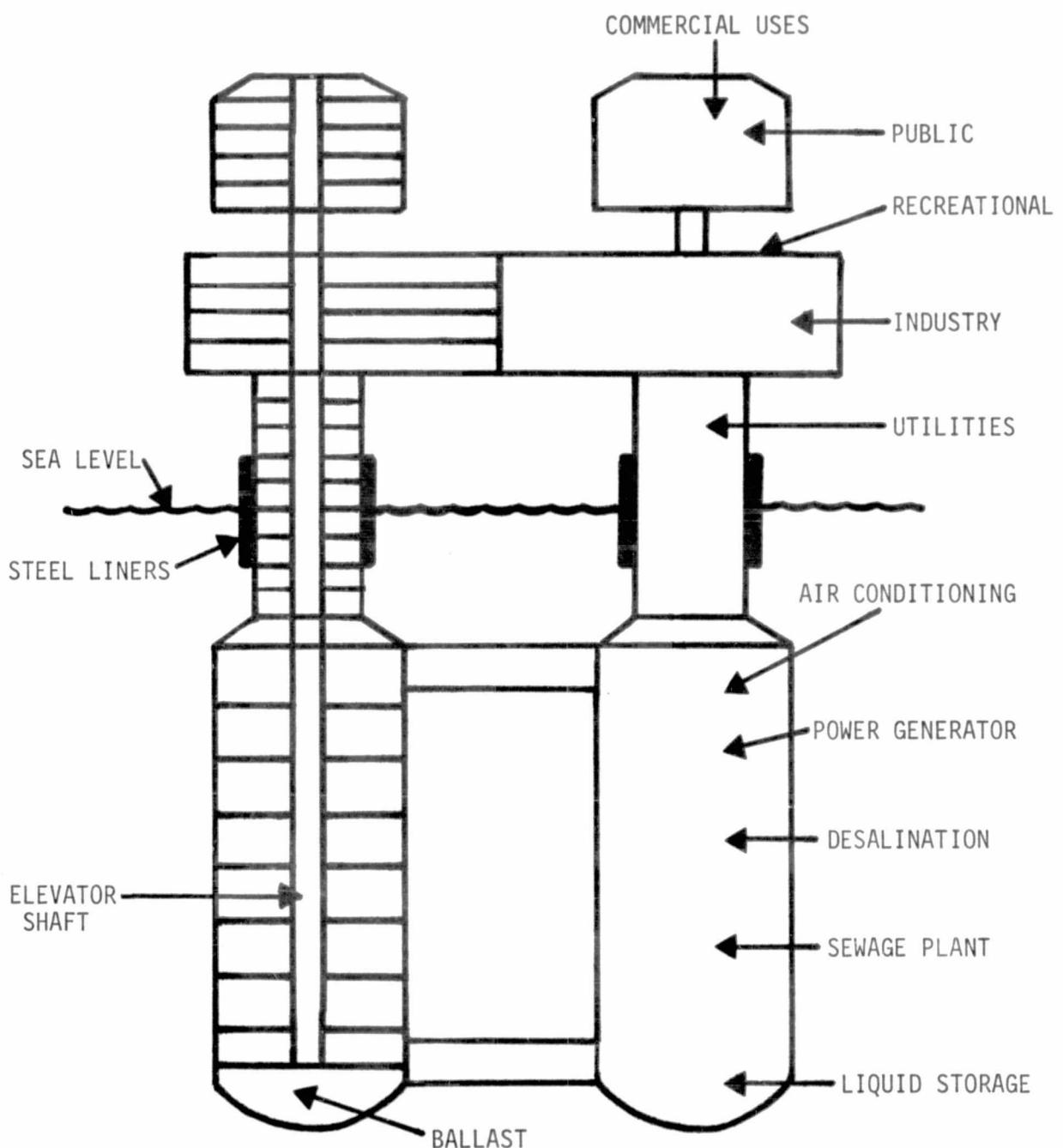


FIGURE 1-4
A FLOATING AND SEMI-SUBMERSIBLE STRUCTURE

(3) The cost of such an island will be a function of use, size, and type of construction. Certain uses will require a particular size and type of structure which will have to be constructed and sited so that it will be able to withstand the probable sea state. Onshore support or facilities may be necessary consideration in a total systems approach to any island during construction and use.

LEGAL-POLITICAL ISSUES

The development of large-scale offshore artificial island complexes, is governed by a host of political, legal, and regulatory constraints. At one end of the continuum are both international laws and agreements (both multi-national and bilateral). At the other end are the federal, state, and local laws regulating jurisdictional authorities and man's use of his natural environment. Local, state, federal, and international politics each play a significant role in determining the extent to which such regulatory arrangements constrain man's activities in the oceans.

Figure 1-5 and Table I-III indicate some of the international and United States laws and agency jurisdictions affecting offshore activities in different geographical ocean zones. This section will discuss these legal-political issues and their implications for offshore developments.

International Law

The 1950's brought three international conventions on the law of the sea, one of which, the Convention on the Territorial Sea and the Contiguous Zone, attempted to define the extent to which a nation could lawfully exercise power over its adjacent ocean waters (called the territorial sea).² While this Convention defined the outer limit of the Contiguous Zone (12 miles), it failed to define the territorial sea. It did stipulate that with few exceptions a nation has exclusive jurisdiction over its territorial sea and limited power over the contiguous zone, primarily to prevent infringement of its customs, fiscal, immigration, or sanitary regulations within its territorial sea.³

The normal baseline from which the breadth of the territorial sea is measured is the low-water line along the coast.⁴ Where the coast is deeply indented or cut into, or where there is a fringe of islands along the coast in its immediate vicinity, mathematical computations are made to "straighten" the coastline and the breadth of the territorial sea is then measured from a

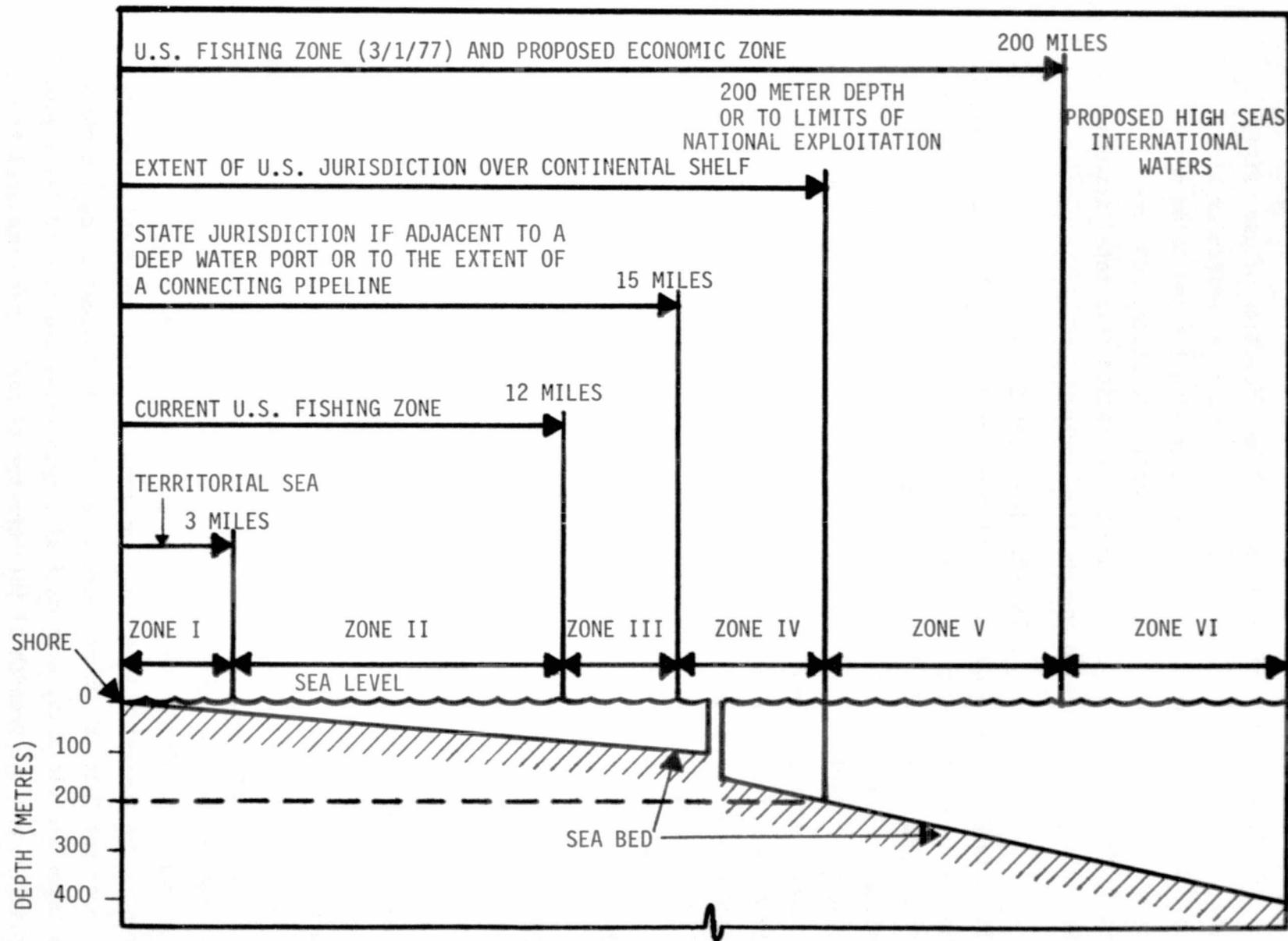


FIGURE I-5
OCEAN ZONING

TABLE I-III
LAWS AND AGENCIES AFFECTING OFFSHORE ZONES

Permits, Acts, Laws, Agencies, Conferences and Conventions	References	Zones
A. International Laws <ul style="list-style-type: none"> 1. Convention on the High Seas 2. Convention on the Continental Shelf 3. Convention of the Territorial Sea and the Contiguous Zone 4. Treaty on the Prohibition of the Emplacement of Nuclear weapons and other Weapons of Mass Destruction on Sea-Bed and the Ocean Floor and in the Sub-Soil Thereof 5. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters 6. Proposed Law of the Sea Conference 	13 U.S.T. 2312 (1962) 15 U.S.T. 471 (1964) 15 U.S.T. 1606 (1964) 23 U.S.T. 701 (1972) 6 E.L.R. 40329 (1972)	II to VI I to IV I to II II to III II to VI I to V
B. Federal Laws <ul style="list-style-type: none"> 1. Commerce and Trade <ul style="list-style-type: none"> (a) National Gas Act (b) Energy Supply and Environmental Condensation Act 2. Conservation <ul style="list-style-type: none"> (a) Federal Water Project Recreation Act (b) National Historic Preservation Act of 1966 (c) Fish and Wildlife Coordination Act (d) Anadromous Fish Conservation Act of 1965 (e) Coastal Zone Management Act of 1972 (f) Fishery Conservation and Management Act 	15 U.S.C. 717 et seq. (1970) 15 U.S.C. 791-98 (1974) 16 U.S.C. 460L-5 et seq. (1970) 16 U.S.C. 470 16 U.S.C. 661-66c (1970) 16 U.S.C. 757-a57f 16 U.S.C. 1456 et seq. 90 STAT. 331 (1976)	Shore to IV Shore to V Shore to V Shore to V Shore to V Shore to I Shore I to V

TABLE I-III (Continued)
LAWS AND AGENCIES AFFECTING OFFSHORE ZONES

Permits, Acts, Laws, Agencies, Conferences and Conventions	References	Zones
3. Navigation and Navigable Waters (a) Rivers and Harbors Act of 1889 (b) Ports and Water Safety Act (c) Federal Water Pollution Control Act (d) Ocean Dumping Act (e) Deepwater Port Act of 1974	33 U.S.C. 401 et seq. 33 U.S.C. 1221-27 (1972) 33 U.S.C. 1251-1376 (1972) 33 U.S.C. 1401-21 (1972) 33 U.S.C. 1501 et seq.	Shore to V Shore to V I to V, possible to IV I to V I to VI
4. Public Health and Welfare (a) Clean Air Act (b) Resource Recovery Act (c) National Environmental Policy Act (d) Noise Control Act of 1972	42 U.S.C. 1857 et seq. (1967) 42 U.S.C. 3251 (1970) 42 U.S.C. 4321 et seq. (1969) 42 U.S.C. 4901 et seq.	Shore to V Shore to IV I to V Shore, possible to V
5. Public Lands (a) Submerged Lands Act of 1953 (b) Outer Continental Shelf Lands Act of 1953	43 U.S.C. 1301 et seq. 43 U.S.C. et seq.	I I to IV
C. State Laws Adjacent State Environmental Policy Act	See Various State Laws	Shore to I
D. Federal Department/Agencies 1. Army Corps of Engineers 2. Coast Guard 3. Department of Transportation 4. Energy Resource Development Administration 5. Federal Power Commission (a) Council on Environmental Quality 6. Nuclear Regulatory Commission 7. Department of Interior (Bureau of Land Management, U.S. Fish & Wildlife Service, U.S. Geological Survey, Office of Oil & Gas, Office of Water Resources Research, Office of Land Use and Water Planning)		Shore to V Shore to V

TABLE I-III (Continued)
LAWS AND AGENCIES AFFECTING OFFSHORE ZONES

Permits, Acts, Laws, Agencies, Conferences and Conventions	References	Zones
8. Department of Commerce (National Oceanic and Atmospheric Administration and Maritime Administration)		Shore to V
9. Department of Justice		Shore to V
10. Federal Energy Administration		Shore to V
11. Federal Maritime Commission		Shore to V
12. Interstate Commerce Commission		Shore to V
E. International Agencies		
1. Intergovernmental Maritime Consultative Organization (IMCO)		III to VI
2. Food and Agriculture Organization (and the numerous International Regional Fishing Commissions and Councils it coordinates) (FAO)		III to VI
3. International Civil Aviation Organization (ICAO)		III to VI
4. International Atomic Energy Agency (IAEA)		III to VI
5. World Health Organization		III to VI
6. World Meteorological Organization (WMO)		III to VI
7. United Nations Educational, Scientific, and Cultural Organization (UNESCO) (And particularly agreements under its International Oceanographic Commission (IOC))		III to VI

mean point along the "straightened" coast.⁵ It should be noted that an island is defined as a naturally-formed area of land.⁶ An artificial island installation, however, does not possess the status of a natural island--it has no territorial sea of its own, and its presence does not affect the delimitation of the territorial sea of the coastal state.⁷ The Convention on the Territorial Sea and the Contiguous Zone stipulated that for the purpose of delineating the territorial sea, the outermost permanent harbor works which forms an integral part of a harbor system, shall be regarded as forming part of the coast.⁸ Therefore, by including a deepwater port as part of an offshore artificial complex, the United States could possibly claim a three mile territorial sea by using the outermost limits of the harbor works as the coastline; however, such an interpretation is subject to question.

When an artificial island is located within the territorial sea, the coastal nation has jurisdiction over the activities on the island by virtue of its sovereignty over these areas. When the island is located outside of its territorial sea international law indicates that structures on the continental shelf operated for the exploration or exploitation of the shelf's resources fall under the jurisdiction of the coastal nation.⁹ If the island is located within or just beyond the territorial sea or on the continental shelf in general, the jurisdictional problem is fairly well confined.

The term "high seas" means all parts of the sea that are not included in the territorial sea or in the internal waters (within land boundaries) of a nation.¹⁰ Historically the high seas were the exclusive sovereignty of no single nation and whether an artificial island constitutes a permitted use of the high seas is open to debate. In short, a country may not build any type of island anywhere it desires; a country wishing to construct an artificial island for any purpose in the high seas will need the consent of the international machinery to do so.

There have been few new international agreements on the law of the sea in the last twenty years, although in recent years an international conference on the law of the sea has met several times attempting to redefine the boundaries which will be extended in all probability. Many countries have abandoned the three-mile (5.56km) jurisdictional limit in favor of a 12-mile (22.22km) limit and some have even extended their sovereignty up to 200 miles (370.40km).¹¹

Officially, the United States still recognizes three miles as its jurisdictional limit, although recently Congress has passed several bills which would extend the authority of the United States further into the ocean. For example the Fishery Conservation and Management Act of 1976 establishes a zone contiguous to the territorial sea, to a distance of 200 nautical miles over which the United States has exclusive management authority over all fishing.¹² Other than for the purposes of conservation and fishery resources management, this act changes no existing territorial or jurisdictional ocean boundary. It should not be assumed that the United States is ready to recognize an exclusive 200-mile boundary.

There is one potentially explosive situation with regard to the unstable jurisdictional boundaries and that involves a militarily operated artificial island. Any country which operated a military base beyond its traditional territorial sea would still expect to control the waters within the vicinity of the island. Other countries, quite naturally, would be reluctant to concede this buffer zone. There must be an international agreement to avoid a situation of this type. Clear definition of jurisdictional limits will:

- (1) enable the nation which has jurisdiction to apply its laws;
- (2) enable the nation which has jurisdiction to tax the island facilities;
- (3) allow the nation which has jurisdiction to sell its own waters and the space they contain;
- (4) promote private capital investment, since it allows investors to understand the relevant legal and jurisdictional factors;
- (5) determine where military bases can be located so that foreign vessels can be kept from the installation;
- (6) indicate when compensation has to be paid (and to whom) for establishing an artificial island; and,
- (7) determine how far off the coast foreign countries may fish.

The most recent proposal by the current Law of the Sea Conference addresses many of the problems on the list above by giving the coastal state a territorial sea of 12 miles and an economic zone of 200 miles.

Under the current proposal, a country would be able to develop an artificial island in the economic zone for: (1) any economic purpose (energy, transportation, mariculture, industry); (2) partially economic purpose (communications, science and engineering); and/or, (3) auxiliary purpose (housing, recreation).

In evaluating multi-purpose offshore industrial complexes, Mangone has summarized that within a nation's (a so-called coastal state's) economic zone

...from an international legal point of view, artificial islands other than those built for exploration or exploitation of the resources of the continental shelf, although not specifically prohibited, have not had any legal sanction beyond the territorial waters of a state. Yet consensus already exists among many states that an extensive coastal zone beyond the territorial waters should be subject to the jurisdiction of the coastal state for mineral resources, fisheries, pollution control, and possibly scientific access, with the right of the coastal state of construct artificial islands for any economic purpose.¹³

Federal and State Jurisdictions

As a general rule, if an artificial island is located within what is now recognized as the territorial sea, the states retain concurrent jurisdiction along with the federal government. Under the Submerged Lands Act of 1953, the states gained control of submerged sands out to three miles,¹⁴ however, the Federal Government retained all rights, powers of regulation, and control of both the lands and navigable waters for the constitutional purpose of commerce, navigation, national defense, and international affairs.¹⁵

The question now arises whether the states' jurisdiction includes structures on the surface. There are no cases on this point, but generally, enabling statutes such as the Submerged Lands Act are liberally construed.

State jurisdiction over artificial islands could be extended in the future. One recently enacted statute, the Deepwater Port Act of 1974, compels this conclusion. This Act provides that no port can be constructed without the approval of the adjacent coastal state if the state is to be directly connected by a pipeline to a deepwater port or would be located within fifteen miles of any such proposed deepwater port. Conceivably, any future statutes which regulate the offshore development of traditionally land-based industries would contain like provisions.

Future laws are tied to future uses. A deepwater port for oil importation is a reality now so there is a law for it. When other offshore uses become practical, there will be laws governing them.

Environmental Legislation

The establishment of an offshore artificial island complex requires compliance with a maze of rules, statutes, and regulations which will govern the use, location, and feasibility of the island. To administer and coordinate the many environmental laws, Congress created the Environmental Protection Agency (EPA) which exercises a tremendous degree of power over the administration of the various licenses and permits programs.¹⁶ Moreover, the EPA establishes many of the guidelines and standards for the various statutory agencies involved. These statutes and guidelines discussed below comprise the primary legal requisites needed to obtain approval to build an artificial island:

National Environmental Policy Act of 1969 (NEPA).¹⁷ In view of the effects of various forms of pollution, Congress enacted the National Environmental Policy Act of 1969 to establish a general rule of law to govern environmental protection. Title I of the act stated that federal agencies were to "...use all means to foster general welfare; create and maintain harmonious conditions with nature; and fulfill the social, economic, and other requirements of present and future generations of Americans."¹⁸ This clause allowed the EPA to broaden its powers to cover any possible environmental exigency (whether present or future) that could arise. Title II of NEPA established the Council on Environmental Quality (CEQ), which analyzes and interprets environmental trends, information, and programs of various agencies. Not only does CEQ develop national environmental policies but also it reviews EPA licensing decisions and environmental impact statements.¹⁹

An important and significant aspect of NEPA is the requirement for all relevant agencies to submit and prepare an Environmental Impact Statement (EIS) for any construction project that will have any effect whatsoever on the environment.²⁰ Substantively, the EIS must contain the following information

- (1) introduction including basic environmental impacts;
- (2) adverse effects;
- (3) short term and long term effects;
- (4) alternatives; and,
- (5) all irretrievable and irreversible commitments of resources involved.²¹

In preparing the EIS the applicant must perceive all relevant impacts of the proposed projects and include them in the statement. In their review of an EIS, the EPA, CEQ, and the Federal District Courts have evaluated the statement on the basis of their:

- (1) being understandable and nonconclusory;
- (2) containing a full range of technical knowledge;
- (3) discussing impacts that are typical of that proposed action;
- (4) recognizing possible "remote" or potential impacts; and,
- (5) presenting short term and long term productivity projections.²²

In sum, NEPA requirements constitute the general constraints with which the proponents of the artificial island must comply. The basic rule to the entire project in its effort to compile an EIS and receive agency approval is "to include every relevant factor" and "to comply to the fullest extent possible."²³

Federal Water Pollution Control Act & Amendment of 1972.²⁴ The establishment of an artificial island and industries thereon undoubtedly will involve the discharge of materials into neighboring waters. Therefore, proponents of the island must review and comply with the stipulations in the Federal Water Pollution Control Act (FWPCA) and its amendments. The act grants the EPA significant authority to:

- (1) regulate discharges into the navigable waters of the United States;
- (2) regulate oil spills and the discharge of "hazardous materials" into the seas;
- (3) finance sewage treatment and research projects;
- (4) support and coordinate local water pollution regulations; and,
- (5) establish permit systems for the various types of substances.²⁵

With the FWPCA, Congress has two goals:

- (1) to eliminate completely discharges in the navigable waters by 1985; and,
- (2) to attain interim goals of water quality for the protection of marine life and human welfare by 1983.²⁶

When reviewing project proposals, the EPA considers the applicant's program in view of these two goals.

The FWPCA governs the direct discharge of various materials (waste, and also dredge and fill materials) to insure compliance with EPA guidelines and

that applicants will employ the best practicable technology currently available and which is economically achievable.²⁷ The EPA also establishes water quality standards for the various bodies of water in and around the United States and under the constraint of "more stringent than necessary," sets specific standards for toxic materials and thermal discharges.²⁸ Finally, the EPA, with the assistance of the Army Corps of Engineers, formulates standards and guidelines for dredge and fill materials to be deposited in the territorial seas.²⁹

The FWPCA permit, which may affect the establishment and construction of an offshore island complex, is that for dredge and fill operations. If an offshore complex is dredged or diked in the territorial sea, the proponents must obtain a permit from the Secretary of the Army, via the Corps of Engineers.³⁰ If the island is to be build beyond the territorial sea limits, the FWPCA dredge and fill permit system will not be applicable.³¹

Marine Protection, Research, and Sanctuaries Act of 1972.³² Congress enacted the Marine Protection, Research, and Sanctuaries Act of 1972 [or Ocean Dumping Act (ODA)] to regulate the discharge of materials in any and all waters of the United States (compare with FWPCA, which regulates discharges in the territorial sea). ODA requires federal permits for:

- (1) transportation from the United States for dumping;
- (2) the actual dumping of such materials;
- (3) the transportation of such materials by a United States agent into any ocean waters; and,
- (4) the construction of fixed structures or artificial islands in ocean waters.³³

With the exception of the construction of fixed structures or artificial islands, the EPA establishes the standards and guidelines for the discharge permits. Basically, the EPA's decision hinges on (1) whether the applicant has a valid need to dump; (2) alternative methods of disposal; and, (3) the potential effect of the dumping. The permit usually designates the dumping site and schedule. The EPA does not permit the dumping of radiological, chemical, or biological waste.

Permits for the construction of fixed structures or artificial islands are administered by the Army Corps of Engineers. The Corps, with EPA guidelines, approves the plans for such facilities, as well as chooses the site for construction. This ODA permit differs from the FWPCA dredge and fill

permit system in that:

- (1) construction and structures in any and all waters of the United States necessitates and ODA dredge and fill permit;
- (2) the ODA gives the EPA extremely broad discretion in establishing permit standards; and,
- (3) under the ODA, the EPA's decision need not have "substantial evidence" to deny the issuance of a permit.³⁵

The proponents of the artificial island must work within the constraints of the Ocean Dumping Act in order to compile the EIS. The discharge of sewage materials from the island will be governed by the EPA, under the Resource Recovery Act of 1970.³⁶

Coastal Zone Management Act of 1972.³⁷ Another act which bears directly on the establishment of an artificial island is the Coastal Zone and Management Act of 1972 (CZMA). Basically, the act grants the Secretary of Commerce and the National Oceanic and Atmospheric Administration (NOAA) authority to coordinate the usage of coastal waters. This power extends to the territorial seas of the United States and must be exercised within the constraints of local governments.³⁸

Clean Air Act and Amendments of 1970.³⁹ In planning for particular uses of an offshore artificial island complex the proponents must consider the Clean Air Act (CAA) and its 1970 amendments. Under the CAA the EPA issues basic regulations, with the goal of preventing the "deterioration" of the atmosphere.⁴⁰ The standards established by the EPA are in frequent flux; however, the general criteria include:

- (1) primary and secondary standards for designated air quality regions;
- (2) specific emission standards for the six basic polluting zones; and,
- (3) individual state and local air quality standards.⁴¹

It should be noted that "new sources" of pollution, such as the creation of an offshore artificial island complex, are subjected to a higher standard of air quality maintenance than are existing structures.⁴² Moreover, the CAA sets specific regulations for highway, rail, and airport systems.⁴³ Whatever transportation systems and industries are anticipated for an offshore complex, the proponents should solicit input from both local and federal research agencies, and seek to minimize emissions of any noxious gases.

Noise Control Act of 1972.⁴⁴ The Noise Control Act of 1972 (NCA) grants the EPA the authority to regulate noise emissions. Depending on the uses of the offshore complex, proposals must obtain a certificate from the EPA to emit "any significant amount of noise into the atmosphere."⁴⁵ This emission includes most transportation vehicles, as well as industrial facilities.

Fish and Wildlife Coordination Act.⁴⁶ The Fish and Wildlife Coordination Act (FWCA) serves as a safeguard for marine life in the waters of the United States. Under the provisions of the Act, any agency, which sanctions the modification of a body of water for any purpose, must obtain approval from the Fish and Wildlife Service of the Department of Interior. In order to secure approval of the EIS, the proponents of the artificial island must include plans to investigate the potential ramifications to fish.⁴⁷ Under the Anadromous Fish Conservation Act of 1965, a similar approval must be obtained from the Secretary of the Interior.⁴⁸

Federal Water Project Recreation Act.⁴⁹ Under the Federal Water Project Recreation Act (FWPRA), the proponents of the offshore complex must consider the ramifications of the project on neighboring recreational facilities. This Act serves as the device to safeguard those individuals who will be in contact with the proposed facility.

National Historic Preservation Act of 1966.⁵⁰ The primary function of the National Historic Preservation Act (NHPA) is to protect the historical and cultural foundations of the nation.⁵¹ For the proponents of the offshore artificial island complex, the act requires that the facility should not disrupt or interfere with any of the historical ports located along the Virginia-North Carolina Coast.

INSTITUTIONAL ARRANGEMENTS

Institutional arrangements affecting offshore artificial complexes are discussed with respect to: (1) the effect of location, (2) ownership alternatives, and (3) financing.

The Effect of Location

More Than 200 miles. The legal regime which would apply to any island complex located on the high seas (beyond the evolving 200 mile economic zone) is highly uncertain and very much dependent upon the outcome of the current

Law of the Sea (LOS) negotiations. Possible regimes range from a condition where the United Nations operates and licenses, and has the authority to regulate and assess fees to a condition where each individual nation engages in any activity it can.

Between 3 and 200 miles. Offshore complexes in the area between 3 and 200 miles (5.56 and 370.40km) probably would be operated by a national institution because of the predominant national jurisdiction over the area. This does not preclude national licensing and subnational operation. The probable variants of a national institution are:

(1) Operating Division within a new Agency/Department of the Ocean: This arrangement, an expanded version of the National Oceanic and Atmospheric Administration (NOAA), would require a significant readjustment of Agency and Department responsibilities, is the most inclusive and the least likely, but ultimately perhaps the most desirable. It presupposes a new Agency/Department of the ocean which would coordinate, regulate and/or operate most of the present ocean-related, non-military activities, together with subsequent activities required for the optimal use of the ocean. The latter would include all offshore artificial complexes.

(2) Independent Agency/Authority: This arrangement envisions an independent agency/authority responsible for the coordination, licensing, regulation and/or operation of all offshore artificial islands. Possible advantages of this arrangement are:

- (1) only one institution to issue special authority bonds;
- (2) better coordination for multi-purpose islands; and,
- (3) no substantial initial opposition because of a relative lack of prior private and bureaucratic vested interests.

But these initial virtues may prove to be a disadvantage to subsequent in-fighting with more entrenched bureaucracies.

(3) Division(s) within existing Department(s): The probable rationale for this type of arrangement presupposes a central use of an offshore island that falls predominantly within the jurisdiction of an existing department. The likely candidates are the Departments of Transportation, Commerce, and Interior. The advantage of this solution is the incorporation of multi-billion projects within existing administrative structures with the least bureaucratic re-shuffling. Complications arise when the multiple uses of an

island are of comparable weight, but the main disadvantage remains as the fragmentation of authority.

Between 0 and 3 miles. Artificial offshore islands in the zone between 0 and 3 miles (0 and 5.56km) probably would be operated by sub-national institutions because of the predominant state jurisdiction over the area. This, however, does not preclude national operation with state concurrence under Federal Enclave jurisdiction. The institutional possibilities in this area include:

(1) Regional Authority: The Regional Authority is indicated if the proposed island is situated within overlapping state jurisdiction, or if it provides contractual public services or physically affects two or more states. Regional Authorities are based on interstate compacts that must be approved by the national government. They are found among riparian states or in some transportation areas, as in the New York/New Jersey Port Authority.

(2) State Agency/Authority: The State Agency/Authority is indicated when the proposed island is situated within the offshore jurisdiction of one state only, when it provides contractual public services and physically affects only one state.

(3) State/Local Agency/Authority: The State/Local Agency/Authority may be indicated if, in addition to the above, the proposed island mainly effects one local government.

(4) State/Regional Planning Commission: This approach may be indicated in the case where the proposed island significantly affects two or more local governments.

(5) Local Authority: This approach could be used in the unlikely event of a major shore-based city or metropolitan area undertaking a project of such magnitude alone.

Ownership Alternatives

Various modes of ownership of an offshore facility will be dependent upon its location, uses, and expense. What follows are some of the more probable ownership alternatives.

Ownership will be considered along these dimensions: (1) combinations of public and private involvement, (2) combinations of United States and foreign involvement, and (3) combinations of public, private, United States, and

foreign methods of ownership.

Public Ownership. One mode of ownership would involve only the public sector. There are two major alternatives: (1) full public ownership involving sole ownership by some government(s) and (2) public corporation, either stock issuing like COMSAT, or non-stock issuing like TVA. When the second dimension of United States and foreign involvement is brought to bear on these alternatives, the following possibilities result: sole United States ownership, United States involved multinational ownership, and sole foreign ownership.

Private Ownership. A second mode of ownership would involve a consortium or a single company. When the second dimension is introduced, the same possible combinations of United States and foreign ownership as found under public ownership occur.

Mixed Public and Private Ownership. The third, and final, general mode of ownership to be considered allows for several combinations of public, private, United States, and foreign involvement. Some of the more obvious alternatives are: (1) United States public with United States private ownership, (2) United States public and foreign private ownership, (3) foreign public and United States private ownership, (4) sole foreign ownership and, finally, (5) various multinational combinations of public and private ownership.

Financing

The degree of financing needed to construct and operate a major offshore island facility will be determined by: (1) the institutional arrangements which cover jurisdiction and administration; (2) the location, water depth, size of the facility, and its mode of construction; and (3) the uses to which the facility will be put, (which in part will dictate the size of the facility) and the construction technique employed.

In terms of scope, financial arrangements will have to consider generating capital to meet the following needs: (1) initial construction of the island itself; (2) construction of user facilities on the island; (3) construction of user- and support-related onshore facilities that are integrated into the island's operation; (4) the amount of and anticipated rate(s) of debt retirement; (5) any security backing designed to provide support or guarantees for investors; and, (6) operating characteristics for the island, and its on-site and related onshore facilities.

In addition to these prime considerations, financing must consider several other potential developments including: (1) an inability to raise sufficient capital from the private sector; (2) the degree to which foreign capital is sought and infused into any island project(s); and, (3) any funds needed to provide an acceptable measure of insurance coverage.

Comparably sized projects, either proposed, under construction, or already built, are few in number. The most closely aligned United States project for a large offshore complex involves the proposed offshore New York Airport, designed to cover 48 square miles (12,400 hectometre²) in relatively shallow water and to be integrated into a deepwater port and railhaul system (together with a nuclear power plant). This has been projected to cost (in 1971 dollars) between approximately \$5 billion (alternate scheme estimated at \$12.5 billion) plus onshore costs. Dike and polder construction techniques would be used.

Based upon the range of possible costs per hectometre² for any offshore island facility, the anticipated cost will be on the order of several billion dollars. The following financial procedures would be considered:

- (1) special purpose bonds;
- (2) special Congressional appropriations;
- (3) tax and other revenues for municipal governments;
- (4) general obligation bonds;
- (5) federal government grants;
- (6) very short-term (10-year) bonds and loans; and,
- (7) special supplemental sales tax.

As an example, the New York Offshore Airport would be financed by the following procedures:

- (1) Airport Authority bonds, to be purchased by N.Y. State (\$500 million), New York City (\$500 million); New York-New Jersey Port Authority (\$1-2 billion), and the general bond market as needed.
- (2) Pre-construction enplaning tax (\$1 per passenger) on all flight passengers using Port Authority airports from 1976 onward.
- (3) Operating fee and charges as used in other airport operations.

Airport Authority bonds would be guaranteed, in the final analysis, by the Federal government, in order to stimulate general bond purchasing as well as to insure support to the three largest purchasers. Bond financing is based on a 25-year period. It has also been suggested that a portion of the revenue realized from the sale of the land presently occupied by John F. Kennedy Airport could be used to finance the Offshore Airport. Also suggested has been

the generation of a certain amount of operating capital from the increased tax bases (e.g., sales, city and state personal income, corporation) that result from the airport's influence.

Based upon the example of the New York Offshore Airport and other means typically tapped for large-scale construction, Table I-IV summarizes possible financing sources for an offshore island.

Based upon the magnitude of financing anticipated and the scale of commonly utilized financial sources, the following recommendations may be applicable:

- (1) The Federal government will have to become heavily involved in any financial scheme for an offshore island facility.
- (2) Joint private/public financing might be very desirable, especially if industry can be interested in funding on-site facilities.
- (3) Investment in an island facility from foreign sources could prove very beneficial and should be encouraged. This may have special relevance to "petrodollars" involving various OPEC national governments.

TABLE I-IV
TYPES OF POTENTIAL FINANCING

<u>CONSTRUCTION/DEBT RETIREMENT</u>	<u>OPERATING EXPENSES</u>
Public Budget at all government levels	Public Budget (if needed)
Bonds Special Purpose (i.e., Maritime Association) Island Agency (Administration/ Authority)	Sale of Space Lease of Space Fees User Special Transfer
Federal Guaranteed Municipal Corporation	Taxes Conventional Regional Transfer Environmental Increased Property, Etc. Transferred Sources (onshore land sales)
Loans World Bank Government (either foreign or domestic) Private Lending Institutions (either foreign or domestic)	
Stocks Public Corporation (i.e., COMSAT, TVA) Private Corporation	

SUMMARY

This chapter has presented a background previewing the parameters against which the development of offshore artificial island complexes can be assessed. Such an assessment is bounded by many interrelated issues, is affected by a multiplicity of factors and forces, and is constrained by some highly complex natural and man-made influences. A difficult, time-consuming assessment process involves the following steps: (1) the identification of the societal need for a certain type of infrastructure and/or facility; (2) the evaluation of the desirability of locating activities to meet those needs on an offshore complex; (3) the estimation and measurement of probable onshore and offshore impacts of such a facility; (4) the decision to go ahead with development; and, (5) the actual implementation and operation phase. A series of interwoven decisions must be made at each stage mentioned above. Little experience exists, if any, in trying to arrive at these decisions, in understanding their interrelationships, and in approaching the problem methodically. The following chapters are devoted to the end of better understanding this decision-making process.

END NOTES

- ¹For examples of these studies see: (1) Avery, W. H., et al. Executive Summary-Maritime and Construction Aspects of Ocean Thermal Energy Conversion (OTEC) Plant Ships. The John Hopkins University, Applied Physics Laboratory, Laurel, Maryland, AOL/JHU, SR 76-1A, April 1976; (2) Bedore, R. L., "Large Floating Platform Technology: A Review," Transactions of the ASME, Journal of Basic Engineering, The American Society of Mechanical Engineers, December 1972, pp. 834-840; (3) Craven, J. P., "Present and Future Uses of Floating Platforms," Oceanus, Fall 1975, pp. 67-71; (4) Grey, J., (Editor), Proceedings--First International Conference on Offshore Airport Technology, sponsored by The American Institute of Aeronautics and Astronautics; Federal Aviation Administration; and International Water Resources Association, Bethesda, Maryland, April 29-May 2, 1973, Volume I and II; (5) Hanson, J. A., (Program Manager) Hawaii's Floating City Development Program, Study by Department of Ocean Engineering, University of Hawaii, Research Sponsor National Oceanic and Atmospheric Administration, Office of Sea Grant, Department of Commerce, Grant SG-2-35243, March 1974, Technical Reports Number 1,2,3,4,5, and 6; (6) Holmes, E.P. Chairman, Offshore Port Facilities, Report by State Task Force to the Commonwealth of Virginia, February 1974; (7) Klepper, O.H. and Anderson, T.D., "Siting Considerations for Future Offshore Nuclear Energy Stations," Nuclear Technology, V. 22, pp. 160-69; (8) Parsons, R. M., "Evaluation of Construction Methods for Offshore Airports," Report prepared by R. M. Parsons Co., Los Angeles, California, August 1969, for Federal Aviation Administration, Final Report, Contract FA-69-WA-2073; (9) Soros, Evaluation of Offshore Terminal System Concepts,

study made by Staff of Soros Associates, Inc., Consulting Engineers, New York, N.Y., A Final Report submitted to U. S. Department of Commerce, Maritime Administration, under Contract Number 1-35409, Executive Summary and Reports, Part 1, 2, and 3, September 1972; (10) Strauss, A. M., SSPP-Solar Sea Power Plants: A Critical Review and Survey, National Aeronautics and Space Administration Report by Goddard Space Flight Center, Greenbelt, Maryland, September, 1974; (11) Trisko, R. L. et al., U. S. Deep Water Port Study, Report prepared by Robert R. Nathan Associates, Inc., Washington, D.C., August 1972, for Department of Army Corps of Engineers, Contract DACW 31-71-C-0045, Volume I, II, III, IV, and V; (12) University of Delaware, An Evaluation of Multi-Purpose Offshore Industrial-Port Islands, Final Technical Report of NSF-RANN: Grant Number GI-43111, May 1975, and (13) Yumori, I. R., Seaward Extension of Urban Systems: Feasibility of Offshore Coal-Fired Electric Power Generation, Report by Oceanic Foundation, Waimanalo, Hawaii, January 1975.

² 15 U.S.T. 1606, T.I.A.S. 5639, ratified 9/10/64.

³ Convention on the Territorial Sea and the Contiguous Zone, Article 24 (1) (a).

⁴ Convention on the Territorial Sea and the Contiguous Zone, Article 3.

⁵ Convention on the Territorial Sea and the Contiguous Zone, Article 4.

⁶ Convention on the Territorial Sea and the Contiguous Zone, Article 10.

⁷ Convention on the Continental Shelf, 15 U.S.T. 471, T.I.A.S. 5578, ratified 6/10/64, Article 5 (4).

⁸ Article 8.

⁹ Supra note 7, Section 5 (4).

¹⁰ Convention on the High Seas, 13 U.S.T. 2312, T.I.A.S. 5200, ratified 9/30/62, Article 1.

¹¹ Irvin L. White, Decision Making for Space, Purdue Research Foundation, West Lafayette, Indiana, 1970, Appendix C.

¹² 90 STAT. Sec. 331.

¹³ Gerald J. Mangone et al. "Legal/Political Aspects" taken from the University of Delaware, An Evaluation of Multi-Purpose Offshore Industrial Islands, Final Technical Report of NSF-RANN: Grant Number GI-43111, May 1975.

¹⁴ 43 U.S.C. Sec. 1301 et seq.

¹⁵ Supra, Note 12, p. 5.

¹⁶ E. L. Dolgin and T.G.P. Guilbert, ed., Federal Environmental Law, (St. Paul: West Publishing Co.), 1974, p. 256.

¹⁷ 42 U.S.C. Sec. 4341 (1969).

¹⁸ 42 U.S.C. Sec. 4341 (2).

¹⁹ Dolgin and Guilbert at 248.

²⁰ 42 U.S.C. Sec. 4341, (102).

²¹42 U.S.C. Sec. 4341, (102) (c).

²²Dolgin and Guilbert at 379.

²³Dolgin and Guilbert at 379.

²⁴33 U.S.C. Sec. 1251.

²⁵Dolgin and Guilbert at 683.

²⁶33 U.S.C. Sec. 1251 (101) (A).

²⁷33 U.S.C. Sec. 1316.

²⁸33 U.S.C. Sec. 1311 (b) (2) (B), 1281 (g) (2), 1321 (b) (5).

²⁹33 U.S.C. Sec. 1322 (g) (h).

³⁰33 U.S.C. Sec. 1251, 403.

³¹Sea, Marine Protection, Research, and Sanctuaries Act of 1972, 33 U. S. C. Sec. 1401.

³²33 U.S.C. Sec. 1401.

³³33 U.S.C. Sec. 1411.

³⁴Dolgin and Guilbert, p. 653.

³⁵Id., at 658.

³⁶42 U.S.C. Sec. 3251-3254 (f).

³⁷16 U.S.C. Sec. 1451-1464.

³⁸16 U.S.C. Sec. 1451-1452.

³⁹42 U.S.C. Sec. 1857-1858 (a).

⁴⁰Dolgin and Guilbert, p. 1060.

⁴¹42 U.S.C. Sec. 1857 (c) (2).

⁴²Dolgin and Guilbert at 1104.

⁴³Id., at 1146.

⁴⁴42 U.S.C. Sec. 4901.

⁴⁵Sea Port of New York Authority V. Eastern Airlines, 259 F. Supp. 745 (E.D.N.Y. 1966).

⁴⁶16 U.S.C. Sec. 661.

⁴⁷16 U.S.C. Sec. 608.

⁴⁸16 U.S.C. Sec. 757.

⁴⁹16 U.S.C. Sec. 460.

⁵⁰16 U.S.C. Sec. 470.

⁵¹16 U.S.C. Sec. 470 (f).

CHAPTER II
PLANNING AND DESIGN

PRECEDING PAGE BLANK NOT FILMED

CHAPTER II

PLANNING AND DESIGN

INTRODUCTION

This chapter will discuss some characteristics of the planning and design process which might assist the conceptualization of proposals for future offshore complexes. It will present a discussion of the variables affecting physical design, suggest a morphological scheme which provides a useful tool for the generation of system alternatives, and discuss the central role of evaluation in the planning process. The last two sections will deal with problems associated with the combination of functions on, and the temporal evolution of, offshore complexes.

THE PROCESS

The process of planning and design involves deliberate action which is directed toward the production of desirable future situations without any undesirable side or after effects. It seeks to (1) find and document the best ways of satisfying a set of societal needs, and in doing so, (2) define these needs, (3) understand the setting within which actions might have to be taken, (4) generate alternative solutions, (5) evaluate alternatives, and (6) select the preferred solution. Due to the complex nature of most planning and design problems, good solutions are often elusive and difficult to find.¹ Each step in the process is often found to be a new and revealing learning experience, and usually results in the development of new insights into both preceding and subsequent steps. A variety of feedback loops and interdependencies among these processes contributes to the complexity of the whole process.

The nature and extent of a plan is dependent largely upon the influence wielded by those controlling physical resources, formulating alternatives, and controlling, or at least responding to, political power. The necessity of reconciling the desires of these as well as other special interests, and the diverse elements of the public should result in plans which are realistic compromises for given conditions. This realism, which in the past often has been based solely on short run considerations, is becoming increasingly tempered by

considerations of consumer protection, environmental quality, and resource conservation.²

Planning can be undertaken at a variety of levels with accompanying variations in the level of detail, jurisdictional concern, and geographic coverage. The range of the functional and geographic variations is shown in Figure 2-1. Irrespective of the level at which the planning activity is undertaken: the basic rationale and methodology remains unchanged and within the framework described above. Each of the agencies involved in offshore complex planning and design will pursue this basic analytical framework with variations accommodating their specific concern, purposes, and geographic coverage.

Variables in Planning

Planning for a desired future situation involves the manipulation of factors within the control of the planner. There are usually referred to as design variables. Examples of design variables with respect to physical design include size, shape, construction methods, and materials used. Once a design variable is determined it becomes a constraint and may take on the property of a contextual variable with respect to further design of that system. In manipulating those variables, the planner is constrained by a variety of contextual variables, which affect overall system performance. These variables either cannot be altered by the planner, or are determined by him to be constraints, prior to system implementation. By his selection of one particular site location for an offshore complex, the designer may exercise indirect control over some of these contextual variables such as oceanographic, geologic, or meterologic conditions. In doing so, contextual variables become transformed into design variables. A third set of variables necessary for the planning and design process is that which measures how well a proposed solution satisfies the purpose for which it is intended and the extent to which it has any adverse or indirect effects. These are called performance variables.

The classification of variables as design or contextual depends on the designer or the planner. If a legal regulation is to be complied with, it would be a contextual variable; however, if a variance to a legal regulation is to be requested, the legal environment then could be considered a design variable. Thus, in the design process, design variables are manipulated under a given context to produce a system which satisfies specified performance criteria.

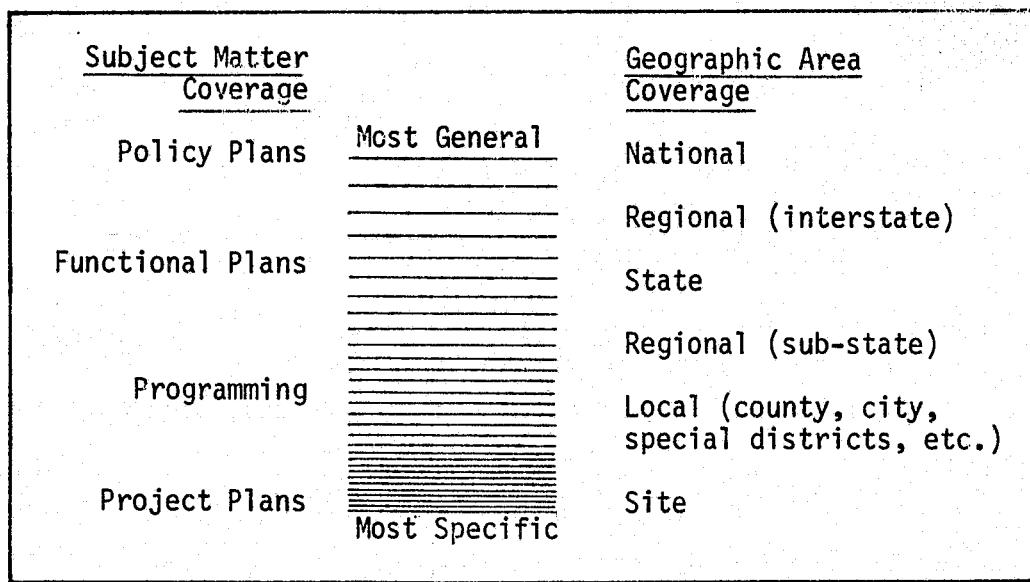


FIGURE 2-1
LEVELS OF THE PLANNING PROCESS

Source: The Environmental Assessment Notebook Series, Notebook 3: Economic Impacts, Washington, DC: United States Department of Transportation, 1975, p. 164.

Detailed listings of design, contextual, and performance variables which might be considered in the design of offshore complexes are presented in Tables II-I, II-II, and II-III. While these listings are not comprehensive they are extensive and should prove useful in any effort which is directed toward the analysis and design of such structures. The listings are referred to as morphological since they delve into the structure of the three types of variables, and provide organized building blocks upon which the analysis, generation, and evaluation of alternative solutions can be based.

Generating Alternatives

In order to generate an alternative plan for an offshore complex the designer will have to select alternative values or configurations for each of a variety of design variables. He must define a set of functions, a spatial organization, a system for island positioning and stability, the structural materials to be used, the environmental controls to be applied, the types of public utilities and service to be provided, the method of island construction, and the types of land access systems. Possible ways in which each of these main categories can be provided are given in the morphological listings. An alternative solution, then, becomes a combination of a selected set of these basic building blocks.

The generation of alternative designs can be accomplished in a variety of ways, varying from the highly informal, to the very formal and rigorous. These include (1) brainstorming, (2) professional judgment and experience, and (3) the enumeration of all logical element combinations which lead to the satisfaction of the professed objective. While the former two methods may continue to produce acceptable solutions frequently, and outstanding ones at times, the latter is a more systematic approach which is more likely to span all feasible options. It is to this end that these detailed listings are provided. One method of obtaining alternative systems using different combinations of elements similar to those given in the morphological listings of design variables is described below.

Consider the case where an offshore complex is needed to solve the problem of delivering crude petroleum to refineries along the Mid-Atlantic coast of the United States. (A similar approach can be used for energy generation, complementary or synergistic industries--individually or collectively--for the

TABLE II-I
A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

- | | |
|---------|--|
| 1 | Composition |
| 1.1 | industries |
| 1.1.1 | primary |
| 1.1.2 | secondary |
| 1.1.3 | supporting |
| 1.2 | services |
| 1.2.1 | institutional |
| 1.2.1.1 | island administration (operation, maintenance, engineering, finance) |
| 1.2.1.2 | transportation (industrial, cranes, motor-pool, individual) |
| 1.2.1.3 | security |
| 1.2.1.4 | fire fighting |
| 1.2.1.5 | evacuation |
| 1.2.1.6 | health (hospital, ambulance, dispensary) |
| 1.2.2 | individual |
| 1.2.2.1 | food (cafeteria, etc.) |
| 1.2.2.2 | recreation |
| 1.2.2.3 | entertainment |
| 1.2.2.4 | religious |
| 1.2.2.5 | commercial (barber shop, department store, etc.) |
| 1.3 | living accommodations |
| 1.3.1 | permanence |
| 1.3.1.1 | transient |
| 1.3.1.2 | non-transient |
| 1.3.2 | group character |
| 1.3.2.1 | individual |
| 1.3.2.2 | family |
| 1.3.2.3 | other |
| 2 | Space organization |
| 2.1 | uncompartmentalized |
| 2.1.1 | undesignated (e.g., open "land") |
| 2.1.2 | designated (e.g., adequate for heavy loads) |
| 2.1.3 | special purpose (e.g., wharf) |
| 2.2 | compartmentalized |
| 2.2.1 | undesignated (subdivided "land" or spaces) |
| 2.2.2 | designated (e.g., designed for industrial and/or manufacturing use) |
| 2.2.3 | special purpose (e.g., vault, "explosion-proof") |
| 3 | Positioning and stability of island |
| 3.1 | horizontal positioning |
| 3.1.1 | free body |
| 3.1.1.1 | unrestrained drift (e.g., buoy for tracing ocean currents) |
| 3.1.1.2 | confined drift (e.g., in an atoll) |
| 3.1.1.3 | dynamic positioning (e.g., by propulsion system) |

TABLE II-I (Cont.)

A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

- 3.1.2 body connected to a stationary object
 - 3.1.2.1 tensile restraint
 - 3.1.2.1.1 moored (slack)
 - 3.1.2.1.2 horizontal net
 - 3.1.2.1.3 suspended
 - 3.1.2.2 compression support-horizontal (e.g., struts used for floating nuclear power plant)
 - 3.1.2.3 moment connection
 - 3.1.2.3.1 bottom resting (e.g., oil platform-CONDEEP)
 - 3.1.2.3.2 bottom penetrating (e.g., oil platform-Texas towers)
- 3.1.3 body as a static object
 - 3.1.3.1 natural island
 - 3.1.3.2 artificial island (e.g., dike and fill, dike and polder)
 - 3.1.3.3 combination
- 3.2 vertical positioning
 - 3.2.1 free body buoyancy
 - 3.2.1.1 neutral
 - 3.2.1.2 constant
 - 3.2.1.3 variable
 - 3.2.2 body connected to a stationary object
 - 3.2.2.1 tensile support
 - 3.2.2.1.1 moored ($B/G > 1$)*
 - 3.2.2.1.2 suspended ($B/G < 1$)
 - 3.2.2.2 compression support
 - 3.2.2.2.1 bottom resting ($B/G < 1$)
 - 3.2.2.2.2 bottom penetrating ($B/G < 1$)
 - 3.2.2.2.3 hold-down ($B/G > 1$)
 - 3.2.2.3 moment connection ($B/G \neq 1$)
 - 3.2.3 body as a static object
 - 3.2.3.1 natural island
 - 3.2.3.2 artificial island
 - 3.2.3.3 combination
- 3.3 stability
 - 3.3.1 site control
 - 3.3.1.1 location with favorable conditions
 - 3.3.1.2 protection provided for island
 - 3.3.1.2.1 high inertia device (fixed breakwater)
 - 3.3.1.2.2 generation of counter wave
 - 3.3.1.2.2.1 pneumatic breakwater
 - 3.3.1.2.2.2 hydraulic breakwater
 - 3.3.1.2.2.3 wave generator

*B=Buoyant Force; G=Gravitational Force

TABLE II-I (Cont.)
A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

		3.3.1.2.3 low inertia energy absorbers (vanes, tubes, tires, logs, etc.)
		3.3.1.2.4 energy conversion devices
3.3.2	island structure control (pitch, roll, yaw, heave, etc.)	
	3.3.2.1 dimensions and shape (hydrodynamics)	
	3.3.2.2 mass distribution, metacenter	
	3.3.2.3 energy absorption or conversion systems on structure	
	3.3.2.4 positioning with respect to ocean floor (e.g., mooring "tuning" and support stiffness)	
	3.3.2.5 combination	
4	Structural materials	
4.1	loadbearing and/or skeleton	
	4.1.1 natural (sand, rock, etc.)	
	4.1.2 manufactured	
	4.1.2.1 concrete (reinforced, prestressed, ferro-cement, polymer-concrete, etc.)	
	4.1.2.2 plastic (fiber-epoxy, etc.)	
	4.1.2.3 metals (steel, aluminum, titanium, etc.)	
	4.1.2.4 composite or combinations	
	4.1.3 waste (e.g., construction debris, slag)	
4.2	envelope or enclosure	
4.2.1	underwater	
	4.2.1.1 steel and other metals with or without coating	
	4.2.1.2 natural materials (stone, sand, rip-rap, etc.)	
	4.2.1.3 concrete and similar manufactured materials with or without coating (dolosse, tribars, etc.)	
	4.2.1.4 plastics and similar synthetic materials (fiber epoxy, etc.)	
	4.2.1.5 glass	
	4.2.1.6 flexible membranes with structural support (vinyl, rubber, etc.)	
	4.2.1.7 insulation	
	4.2.1.8 others and combinations	
4.2.2	above water (as appropriate for functions and similar to 4.1 and 4.2.1 above)	
4.3	foundation	
	4.3.1 none	
	4.3.2 caissons	
	4.3.3 piles	
	4.3.4 cast-in-place concrete	
	4.3.5 others	
4.4	elements linking foundation and structure	
	4.4.1 compression	
	4.4.1.1 metals (steel, etc.)	
	4.4.1.2 concrete	

TABLE II-I (Cont.)
A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

	4.4.1.3	natural materials
	4.4.1.4	synthetic materials
	4.4.1.5	waste
4.4.2	tension	
	4.4.2.1	metallic (wire rope, etc.)
	4.4.2.2	nonmetallic (Kevlar, etc.)
4.5	deterioration control	
4.5.1	impregnation during manufacturing	
	4.5.1.1	metallic (alloys)
	4.5.1.2	chemical
	4.5.1.3	others
4.5.2	coating	
	4.5.2.1	bituminous
	4.5.2.2	vinyl
	4.5.2.3	epoxy
	4.5.2.4	metal plating
	4.5.2.5	other surface applications
4.5.3	cathodic protection	
4.5.4	removal of bio-fouling	
	4.5.4.1	on-site
	4.5.4.2	dry-dock (floating)
	4.5.4.3	dry-dock (shore line)
	4.5.4.4	on-shore
4.6	reconstruction and restoration (storm, collision, aging)	
4.6.1	on-site	
4.6.2	dry-dock (floating)	
4.6.3	dry-dock (shore line)	
4.6.4	on-shore	
5	Occupancy factors	
5.1	ventilation	
	5.1.1	natural
	5.1.2	mechanical
5.2	thermal environment (as necessary for equipment, process, and human comfort)	
	5.2.1	none
	5.2.2	heat
	5.2.3	cool
5.3	humidity	
	5.3.1	no control
	5.3.2	changes resulting from other operations
	5.3.3	full control
5.4	air pollution (incl. odor)	
	5.4.1	no control
	5.4.2	controlled
		5.4.2.1 removal
		5.4.2.2 treatment (modification)

TABLE II-I (Cont.)
A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

- 5.5 noise
 - 5.5.1 no control
 - 5.5.2 control at source (e.g., elimination, masking, absorption)
 - 5.5.3 control of transmission media (e.g., attenuation by materials, vacuum, separation, location)
 - 5.5.4 control by receiver protection (e.g., ear muffs, ear plugs)
- 5.6 lighting
 - 5.6.1 natural
 - 5.6.1.1 direct (sunlight, etc.)
 - 5.6.1.2 indirect (skylight, etc.)
 - 5.6.2 artificial
 - 5.6.3 combinations
- 6 Utility factors
 - 6.1 energy
 - 6.1.1 primary
 - 6.1.1.1 transmission (import or export)
 - 6.1.1.1.1 electrical
 - 6.1.1.1.1.1 cables (submarine, tunnel surface (trestle, etc.), aerial)
 - 6.1.1.1.1.2 electromagnetic
 - 6.1.1.1.1.3 stored (battery)
 - 6.1.1.1.2 fluid
 - 6.1.1.1.2.1 continuous (e.g., pipeline)
 - 6.1.1.1.2.2 bulk (e.g., tank storage of hydrogen)
 - 6.1.1.2 generation
 - 6.1.1.2.1 steam turbine
 - 6.1.1.2.1.1 conventional fuel (e.g., oil, natural gas, coal, solid waste)
 - 6.1.1.2.1.2 unconventional fuel (e.g., hydrogen oxidation)
 - 6.1.1.2.1.3 nuclear fuel
 - 6.1.1.2.2 gas turbine
 - 6.1.1.2.3 combustion engines (e.g., gas, gasoline, diesel)
 - 6.1.1.2.4 solar collectors (e.g., thermal, photo-voltaic)
 - 6.1.1.2.5 thermal gradient (e.g., OTEC, thermocouples)
 - 6.1.1.2.6 fuel cells
 - 6.1.1.2.7 geothermal
 - 6.1.1.2.8 ocean tides
 - 6.1.1.2.9 ocean waves
 - 6.1.1.2.10 others (e.g., exothermic reactions)

TABLE II-I (Cont.)

A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

	6.1.1.3 storage
	6.1.1.3.1 potential
	6.1.1.3.1.1 chemical (e.g., batteries)
	6.1.1.3.1.2 mechanical (e.g., compressed gas, pumped storage)
	6.1.1.3.2 kinetic (e.g., flywheel)
6.1.2	secondary (see 6.1.1 above)
	6.1.2.1 secondary recovery (e.g., heat)
	6.1.2.2 scavenging (e.g., pressure drop through turbine)
	6.1.2.3 synergy
	6.1.2.4 others
6.1.3	emergency
	6.1.3.1 batteries
	6.1.3.2 combustion
	6.1.3.3 gas turbines
	6.1.3.4 others
6.2	water
6.2.1	produce
	6.2.1.1 rainwater
	6.2.1.2 wells
	6.2.1.3 condensate (e.g., from air conditioning)
	6.2.1.4 desalination
	6.2.1.5 recycle
	6.2.1.6 oxidation of hydrogen (burn hydrogen fuel)
6.2.2	recycle and recovery
6.2.3	import
	6.2.3.1 tanker
	6.2.3.2 pipeline
	6.2.3.3 towed bladder
	6.2.3.4 towed iceberg
6.3	waste (liquid, solid)
	6.3.1 no processing (dump, if permitted)
	6.3.2 treat
	6.3.3 recycle
	6.3.4 export
	6.3.5 combinations
6.4	transportation
6.4.1	internal on the island
	6.4.1.1 personnel
	6.4.1.1.1 powered (e.g., cableway guideway, railway, motor vehicles, jet pods, escalators, elevators, bicycles, moving passageways)
	6.4.1.1.2 unpowered (e.g., walkways, stairs, chutes, poles)
	6.4.1.2 solids
	6.4.1.2.1 powered (e.g., cableway, conveyor, forklift,

TABLE II-I (Cont.)

A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

		crane, rail, truck, elevator, vacuum)
6.4.1.3	6.4.1.2.2	unpowered (e.g., chute, conveyor, dolly)
	6.4.1.3 fluids (liquid and gas)	
	6.4.1.3.1	pipelines (e.g., vacuum, potable water, waste water, storm water, process fluids, compressed air, vacuum waste)
	6.4.1.3.2	rigid vessels (e.g., tanktruck, pressure vessel)
	6.4.1.3.3	flexible vessels (e.g., bladders)
6.4.1.4	electrical	
	6.4.1.4.1	distribution (e.g., energy)
	6.4.1.4.2	communications (e.g., telephone, data acquisition, alarm)
6.4.2	6.4.1.5 others (e.g., island ballast control system)	
6.4.2 external	(to and from) island	
	6.4.2.1 personnel	
	6.4.2.1.1	surface (e.g., boat, ship, hydrofoil, surface effect, trestle, causeway, bus, truck, train)
	6.4.2.1.2	subsurface (e.g., tunnel with rail, bus, auto, conveyor; submarine)
	6.4.2.1.3	aerial (e.g., dirigible, VTOL, STOL, glider helicopter, parachute, airplane, jet pod, cableway)
	6.4.2.2 solid (use 6.4.2.1 above for selected modes)	
	6.4.2.2.1	surface (e.g., barge)
	6.4.2.2.2	subsurface (e.g., trained marine life-dolphins)
	6.4.2.2.3	aerial (e.g., trained Aves and Chiroptera, ballistic projectile)
	6.4.2.3 fluids (use 6.4.2.1 and 6.4.2.2 above for selected modes)	
	6.4.2.3.1	surface (e.g., bladder)
	6.4.2.3.2	subsurface (e.g., pipeline-tunnel or submarine)
	6.4.2.3.3	aerial
6.5	communication	
6.5.1	internal	
	6.5.1.1	electromagnetic
	6.5.1.2	mail
	6.5.1.3	visual
	6.5.1.4	acoustical
	6.5.1.5	others
6.5.2	external	
	6.5.2.1	electromagnetic
	6.5.2.1.1	direct (e.g., radio, micro-wave)
	6.5.2.1.2	indirect (e.g., satellite)
	6.5.2.2	mail

TABLE II-I (Cont.)
A MORPHOLOGICAL LISTING OF DESIGN VARIABLES

		6.5.2.3 visual depending on distance and visibility
		6.5.2.4 acoustical
		6.5.2.5 others
6.6	navigation aids (above surface, surface, below surface)	
	6.6.1 electromagnetic	
	6.6.2 acoustical	
	6.6.3 visual	
	6.6.4 other	
7	Construction	
7.1	characteristics of the separately built major structural units	
	7.1.1 number (of units)	
	7.1.2 size-volume-weight (per unit)	
7.2	site	
	7.2.1 unprotected	
	7.2.2 cofferdam	
	7.2.3 floating plant	
	7.2.3.1 not a part of the structure	
	7.2.3.2 part of the structure	
	7.2.4 stationary plant	
	7.2.4.1 not a part of the structure	
	7.2.4.2 part of the structure	
	7.2.5 dry dock	
	7.2.5.1 floating	
	7.2.5.2 shore line	
	7.2.6 on land	
7.3	process	
	7.3.1 on site	
	7.3.2 prefabrication (small parts are pre-made but assembled in the field)	
	7.3.3 preassembled major structural units (units are connected at the site)	
	7.3.4 completed structure towed to position	
7.4	connectors of major components	
	7.4.1 no physical connection (surface tension, vacuum, magnetic, etc.)	
	7.4.2 flexible connection (cable, pin, roller, etc.)	
	7.4.3 semirigid (truss, frame, etc.)	
	7.4.4 rigid (welding, epoxy, glue, etc.)	

TABLE II-II
A MORPHOLOGICAL LISTING OF CONTEXTUAL VARIABLES

- 1 Oceanographic
 - 1.1 waves (variation with depth and season, forecasts)
 - 1.2 currents (variation with depth and season, forecasts)
 - 1.3 swells (forecasts)
 - 1.4 tides
 - 1.5 bathymetry
 - 1.6 erosion-accretion process
 - 1.7 others (e.g., seiche)
 - 1.7.1 temperature (variation with depth and season)
 - 1.7.2 salinity distribution (variation with depth and season)
 - 1.7.3 chemical content (variation with depth and season)
 - 1.7.4 suspended matter, turbidity (variation with depth and season)
 - 1.7.5 density distribution (variation with depth and season)
 - 1.7.6 regional streams-estuaries-lagoons (seasonal flows, sediment loads, water quality, etc.)
- 2 Geological
 - 2.1 seafloor soil structure
 - 2.2 seafloor soil strength, deformations
 - 2.3 seismic hazard, faults
 - 2.4 aquifer interruption from channel dredging
 - 2.5 natural resource potential
- 3 Meteorological
 - 3.1 wind (speed, direction, probability and extent)
 - 3.2 storms and hurricanes
 - 3.3 precipitation (rain, snow, sleet, ice, etc.)
 - 3.4 fog
 - 3.5 visibility
 - 3.6 ceilings
 - 3.7 temperature
 - 3.7.1 dry-bulb
 - 3.7.2 wet-bulb
 - 3.8 degree-days
 - 3.8.1 heating
 - 3.8.2 cooling
 - 3.9 atmospheric inversion
 - 3.10 solar heat gain
 - 3.11 sky luminance
- 4 Biological-geographical-demographical
 - 4.1 biota
 - 4.1.1 total ocean bio-mass
 - 4.1.2 ocean bio-fouling
 - 4.1.3 birds
 - 4.1.4 rodents
 - 4.1.5 others
 - 4.2 energy (present and projected)
 - 4.2.1 supply sources

TABLE II-II (Cont.)

A MORPHOLOGICAL LISTING OF CONTEXTUAL VARIABLES

- | | |
|---|--|
| | <ul style="list-style-type: none"> 4.2.2 production sites 4.2.3 demand locations 4.3 utilities (present and projected) <ul style="list-style-type: none"> 4.3.1 on-shore <ul style="list-style-type: none"> 4.3.1.1 pipelines 4.3.1.2 cables and wires 4.3.1.3 electromagnetic radiation 4.3.2 off-shore <ul style="list-style-type: none"> 4.3.2.1 pipelines 4.3.2.2 cables 4.3.2.3 electromagnetic radiation 4.4 transportation (present and projected) <ul style="list-style-type: none"> 4.4.1 on-shore <ul style="list-style-type: none"> 4.4.1.1 shipping 4.4.1.2 rail 4.4.1.3 highway 4.4.1.4 air 4.4.1.5 others 4.4.2 off-shore <ul style="list-style-type: none"> 4.4.2.1 sea 4.4.2.2 air 4.4.2.3 others (e.g., tunnel) 4.5 commodities (present and future) <ul style="list-style-type: none"> 4.5.1 supply (quantity and location) 4.5.2 production sites and capacities 4.5.3 demand (quantity and location) 4.6 population distribution (present and projected) <ul style="list-style-type: none"> 4.6.1 total 4.6.2 labor pool 4.6.3 transportation needs 4.7 others (existing and proposed) <ul style="list-style-type: none"> 4.7.1 exclusion and restricted areas 4.7.2 military facilities 4.7.3 disposal areas (explosives, waste, etc.) |
| 5 | Archeological |
| | 5.1 historical consequences (lost communities, notable wrecks) |
| | 5.2 nuisance (remains of no significant value) |
| 6 | Aesthetic |
| | 6.1 seascape |
| | 6.2 underwater |
| 7 | Legal-political-military-institutional |
| | 7.1 discount-interest rates |
| | 7.2 escalation factors |
| | 7.3 military requirements |
| | 7.4 others (details outlined in Legal-Political section) |

TABLE II-III
A MORPHOLOGICAL LISTING OF PERFORMANCE VARIABLES

- 1 System (function) effectiveness (throughput, efficiency, speed, capacity, etc.)
 - 1.1 transportation (as an example)
 - 1.1.1 carry:
 - 1.1.1.1 quantity-distance per unit time (e.g., tonne-km per yr., litre-km per yr., passenger-km per yr.)
 - 1.1.1.2 quantity per unit time (e.g., tonne per second, etc.)
 - 1.1.2 store: quantity or capacity (e.g., tonnes, square metre, cubic metre, etc.)
 - 1.2 energy
 - 1.2.1 efficiency = energy out/energy in (e.g., joules out per joules in)
 - 1.2.2 net energy = energy in - energy lost (e.g., joules in - joules lost)
 - 1.3 industry and processing (including transportation)
 - 1.3.1 quantity per unit time (e.g., tonnes per second, etc.)
 - 1.3.2 profit = income - costs
 - 1.4 flexibility and adaptability to anticipated and unforeseen change
 - 1.5 salvage value
 - 1.6 combinations (typical cost effectiveness parameters can also be included by combining appropriate cost measures with effectiveness measures, e.g., storage capacity in tonnes would become \$ per tonne capacity)
- 2 Environmental impact
- 3 Safety
 - 3.1 evacuation
 - 3.2 redundancy and reliability of essential utilities
 - 3.3 emergency procedures in case of production malfunctions
 - 3.4 redundancy and reliability of environmental systems
 - 3.5 structural
 - 3.6 collision or crash
 - 3.7 explosion
 - 3.8 fire
 - 3.9 sabotage
 - 3.10 leaks
 - 3.11 health facilities (normal and emergency)
 - 3.12 other (lightning, gas, radiations, etc.)
- 4 Comfort
 - 4.1 motion perception
 - 4.2 thermal comfort
 - 4.3 humidity (non-thermal)
 - 4.4 air quality
 - 4.5 acoustical
 - 4.5.1 frequency distribution
 - 4.5.2 spatial distribution
 - 4.5.3 other effects (echo, flutter, reverberation, etc.)

TABLE II-III (Cont.)
A MORPHOLOGICAL LISTING OF PERFORMANCE VARIABLES

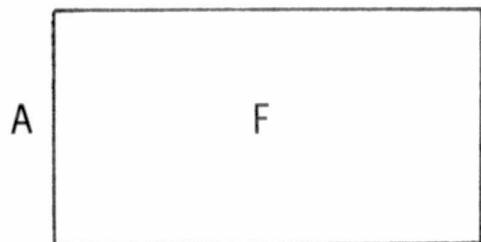
- | | |
|-------|--------------------------------|
| 4.6 | visual |
| 4.6.1 | illumination levels |
| 4.6.2 | distribution of illumination |
| 4.6.3 | glare |
| 4.6.4 | quality and color |
| 5 | Aesthetics |
| 5.1 | interior facilities |
| 5.2 | exterior facilities |
| 5.3 | seascape |
| 5.4 | underwater |
| 6 | Cost |
| 6.1 | initial |
| 6.2 | operating and maintenance |
| 6.3 | disposal (or salvage value) |
| 7 | Life stream, cost, utilization |
| 7.1 | life span |
| 7.2 | schedule |
| 7.2.1 | design |
| 7.2.2 | construction |
| 7.2.3 | testing (acceptance) |
| 7.2.4 | operating and utilization |
| 7.2.5 | decommissioning |

entire island complex.) Crude petroleum is transported in supertankers which require water depths in excess of that available currently at suitably located ports. The function (F) of the offshore complex is to alleviate the problem caused by the incompatibility of deep-draft tankers and shallow Mid-Atlantic ports.

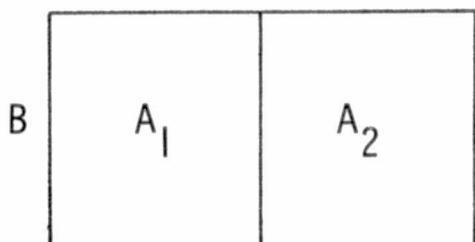
Given that function, one then attempts to generate and categorize a list of all possible alternative methods of achieving success. One procedure for generating alternatives is the use of a schematic technique known as the Morphological Box, one variant of which is shown in Figure 2-2. The procedure of using a morphological box can be summarized as follows. Let the function be represented by a box: Define a disjunction of alternatives as a situation in which the alternatives are mutually exclusive, i.e., only one of a set need be selected; and a conjunction as a situation in which all functions in a set need to be provided jointly to satisfy an alternative. Divide the box vertically if there is a disjunction (or) and horizontally if there is a conjunction of alternatives or functions. Then, any combination indicated by a line crossing all the horizontal dividers without crossing a vertical divider is an alternative for the provision of the function. Note that in the present case the tanker-port incompatability problem is simplified for purposes of example and is, therefore, non-exhaustive. The morphological boxes could be expanded to introduce more cells in either the columns or rows, but the reader should assume in this illustration that each box in Figure 2-2 does exhaust all alternative courses of action. Assume, therefore, that the task of resolving the problem (F) could be provided in one of only two ways (as shown in Figure 2-2, B): Crude petroleum can be (1) transshipped (A_1) or (2) processed (A_2) at the offshore complex, i.e., move refineries and storage to the offshore complex.

If the crude is to be transshipped, one needs both a terminal (f_1) and a pipeline (f_2) to carry the crude to shore for refining there; if it is to be processed, one needs a terminal (f_3), and a processing capability (f_4), and a pipeline (f_5) to carry the refined product to shore as shown in Figure 2-2, C.

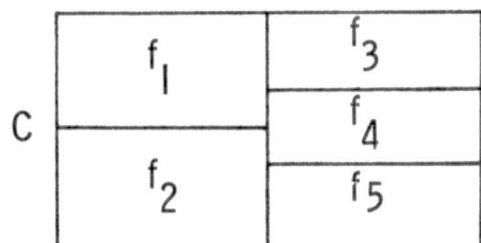
If a decision is made to use a terminal and a pipeline alternative, the types of terminal facilities could include either a single point mooring (a_{11}) and a pipeline (a_2), or a constructed island terminal (a_{12}) and a pipeline (a_2). If processing (a_4) takes place on the island, then the refined petroleum is unloaded at a single point mooring (a_{31}) and moved to shore by pipeline (a_5), or



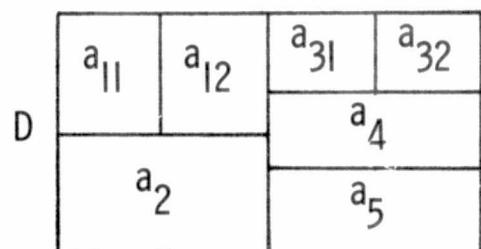
FUNCTION (F): Alleviate problem caused by incompatibility of deep-draft tankers and shallow Mid-Atlantic ports.



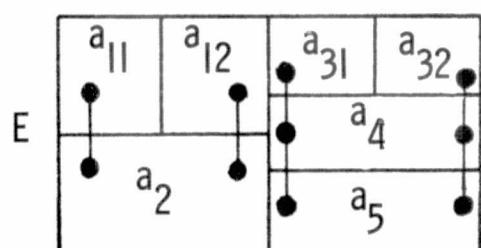
ALTERNATIVE ways of accomplishing the function F: tranship or process.



SUBFUNCTIONS necessary to achieve alternatives A₁ and A₂: terminal and pipeline or terminal and process and pipeline.



ALTERNATIVE ways of achieving each of the subfunctions: SPM and pipeline or island terminal and pipeline or SPM and processing and pipeline or island terminal and processing and pipeline.



PLANNING ALTERNATIVES: indicated by lines showing all possible ways of achieving F.

FIGURE 2-2
FUNCTIONAL ANALYSIS
AND THE GENERATION OF PLANNING ALTERNATIVES

a combination of an island terminal (a_{32}) and a pipeline (a_5) are used as shown in Figure 2-2, D. The four alternative ways of achieving (F) are shown by the connecting lines in Figure 2-2, E. The morphological box has thus been used to provide a theoretical schematic representation of the alternatives for fulfilling the function in question.³

Once an exhaustive set of alternative solutions has been generated, the problem of assessing the general worth of each alternative remains to be tackled.

Evaluation

An evaluation is a judgment of the general worth of (1) something (e.g., an activity, event, object, or situation) made by (2) an individual (or group) using (3) a specific value system, at a certain (4) time, for a specified (5) purpose. If any component of the judgment changes, any given evaluation based on that judgment may be modified subsequently (e.g., the same thing may be evaluated differently by different people, or differently at different times by the same person).

Although in daily life one is seldom required to be fully explicit about all of his reasons for a given evaluation, the thrust of judgments in planning and design is to be as explicit and as thorough as possible so that reasons for final decisions can be understood. For purposes of planning and design, judgments can be classified in two ways: (1) deliberative or non-deliberative; and (2) overall or partial. A judgment is deliberative if reasons are given for it; otherwise it is non-deliberative. In planning and design a judgment is overall if it incorporates all features relevant to the problem at hand; otherwise it is partial. Ideally, in planning and design, one strives to make judgments as deliberative and as complete as possible in identifying particular system components, determining their individual worth, and selecting from among alternative options those choices which best satisfy the design criteria.

These qualifying remarks are needed concerning the nature of evaluation in planning and design: (1) in practice it is difficult, if not impossible to ascertain that all relevant features have been deliberated, one does the best possible within the contextual, temporal, and resource limitations of the problem; (2) it is impossible to deliberate every judgment exhaustively--one ceases deliberation when its further continuance is viewed as unnecessary.

To illustrate this discussion, assume that aesthetics, costs, and safety are three of the performance variables judged to contribute to the overall worth of an offshore complex. (See Table II-III for a suggested listing of such performance variables.) For each performance variable selected, deliberation would enable generation of a morphology peculiar to that variable. Considering "costs," for example, deliberation might result in judgments about costs for initiation, operation, maintenance, and decommissioning of the offshore complex. Ideally, independent judgments could be made about the "cost" variables independent of others such that the characteristics and further breakdowns of cost could be evaluated exhaustively.

In planning and design, the process of evaluation is in continual flux. It is tied to, and reacts to, subjectivity and synergistic fluidity of design, performance, and contextual variables as they juxtapose with individual value systems, time, and purpose.

SYNERGISTIC EFFECTS

Early in the planning phase, planners of future offshore complexes will have to address the question of selecting functional combinations for them. It seems highly probable that such facilities will have to provide a multiplicity of functions, in order to capitalize on the synergistic effects which might accrue from the thoughtful agglomeration of functions. This section will address the question of selecting functional combinations which exhibit such synergistic effects, i.e., those which produce a collective effect which is in excess of the summation of the effects produced by each function when performed separately.

Since the costs and benefits of an activity are often identified with inputs and outputs respectively, it is convenient to analyze for synergy by observing the basic inputs/outputs, and processes associated with possible offshore complex functions as shown in generalized form in Figure 2-3. Using this scheme one can identify certain types of possible synergies arising from the coupling of two or more processes. For example, if the waste energy (output) of one system is used as part of the energy requirement (input) of another, a possible synergy (called an output-input synergy) may result. General types of synergy organized along these lines are shown in Table II-IV along with some examples. The examples are neither exhaustive nor limiting. It should

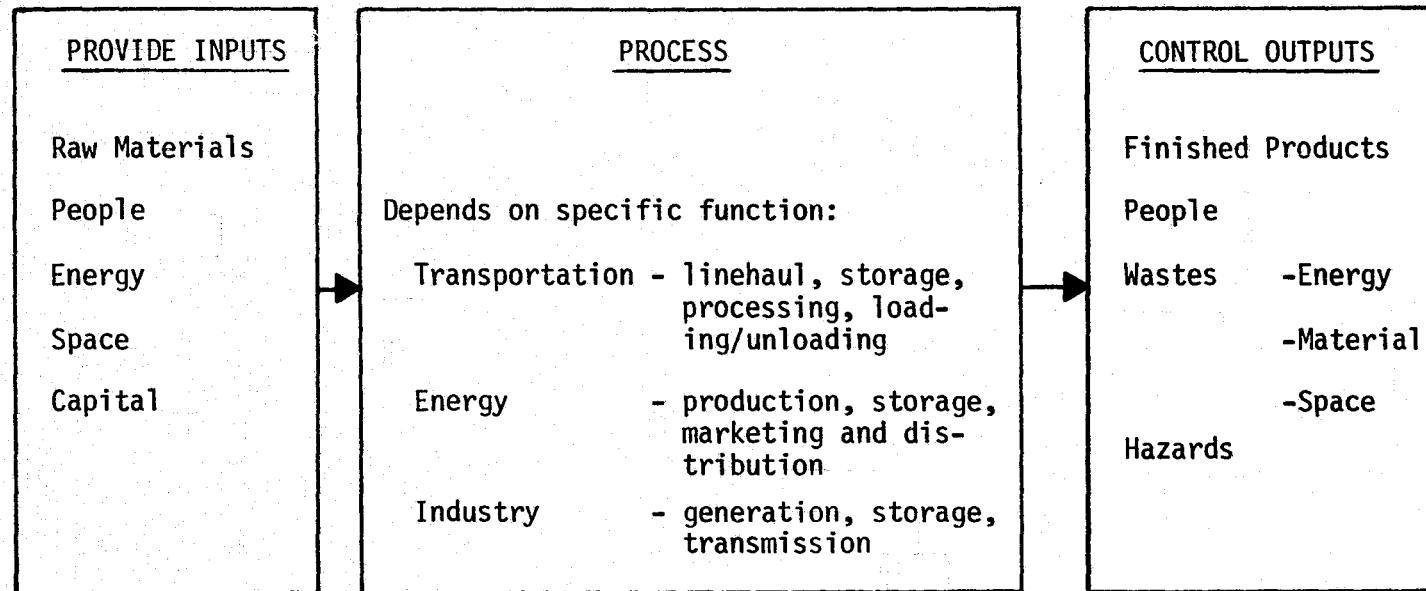


FIGURE 2-3
GENERAL FUNCTIONS FOR OFFSHORE COMPLEXES

TABLE II-IV
TYPES AND EXAMPLES OF SYNERGY

Type	Example/Explanation
Output-Input	<ul style="list-style-type: none"> * Use waste heat from one activity as input for another, e.g., thermal effluent of fossil plant to enhance thermal gradient, ΔT, for ocean thermal energy conversion. * Use non-organic solid waste from one activity as fill material for another e.g., to construct more island "real estate." * Use volume-space created by establishment of air landing field (area-space) for an activity requiring volume-space, e.g., warehousing and storage. * Use organic solid waste to produce methane to help meet a fuel requirement.
Output-Output	<ul style="list-style-type: none"> * Use identical hazard control facility or environment for several functions. * Use a single conveying system for more than one industry e.g., from plant to pier.
Input-Input	<ul style="list-style-type: none"> * Achieve economies of scale by coupling activities requiring similar inputs.
Process-Process:	<ul style="list-style-type: none"> * Achieve a storage function for an industrial activity with a storage function within transportation. * Achieve increased efficiency by overlapping process equipment or procedures. * Use low grade petroleum residuals as a slurry medium for coal.

be noted that the basic types of synergies outlined in Table II-IV may apply to subactivities within a major function as well as to the major functions themselves. For example, the use of a canal for both navigation and irrigation might be more cost effective than using two different canals for each of these separate functions.

The identification of conditions which enhance synergistic effects is at the heart of the systems approach to problem-solving and may prove to be a key to the success of future offshore complex design. The particular decision-maker in each individual situation will be required to decide on both the scope of the synergistic considerations, and on the depth and detail to which that scope should be pursued. The following steps outline one method for observing and evaluating synergistic effects.

- (1) Conceptualize an offshore complex with a primary function such as transportation. This procedure will give an initial understanding of the net benefits and the basic inputs, outputs, and process configurations associated with various alternatives.
- (2) Conduct a first round Input/Output/Process analysis for secondary functions.
- (3) Compare the Input/Output/Process relationships of the transportation functions with those of the secondary functions considered, emphasizing characteristics which are likely to give rise to synergistic effects (e.g., net efficiency, speed, economics of scale, waste utilization, etc.). Detail in this step may range from answering simple, cursory questions such as: "What extra (wasted) space is generated by the transportation complex?" or "What industries require this amount of space?", to using formal mathematical models such as input/output analysis.
- (4) Conceptualize an offshore complex with coupled primary and secondary functions.
- (5) Compare net benefits of offshore complexes with and without the coupling of different functions for the effects of the synergy. If the net benefits of the primary function plus the net benefits of the secondary functions are exceeded by the net benefits of the combined primary and secondary functions, then positive synergy has resulted from the combined design.
- (6) Iterate the entire procedure looking for tertiary synergies as appropriate.

TEMPORAL EVOLUTION

Offshore complex design must take into account the temporal dimensions associated with design alternatives. A project's evolution can be divided into a series of phases including (1) design, (2) construction, (3) testing,

(4) operation, and (5) decommissioning. These phases must be identified in the light of both anticipated needs and anticipated costs of meeting those needs.

Consider, for example, an offshore complex whose primary function is the transportation of oceanborne bulk materials to meet future demand in the North Atlantic region of the United States in the year 2000. The projected demand for oceanborne imports and exports in the design year must first be estimated. In order to develop a specific design objective, several other factors should be examined including the projected growth of existing ports and other plans to meet this demand. For purposes of illustration, assume that existing plans and facilities will meet the annual needs for import and export demands until 1985 and that another (or expanded system) will be needed to handle the additional demands beyond 1985. Hence, the new system should begin operation in 1985, progress toward full operation by the year 2000, maintain that level of operation until 2020, and phase out of operation by 2025. (Of course an actual analysis should consider demand beyond 2025 as well as the eventual expansion of the facility to meet very long range demand projections.) The assumed functions and anticipated needs suggest an evolution schedule as shown in Figure 2-4.

As a final point, it should be noted that each offshore complex alternative involves costs distributed overtime for planning and design, initiation (construction, etc.), operation and maintenance, and decommissioning. These are mapped schematically in Figure 2-4 together with the anticipated utilization of the system which is one measure of its benefit. It must be emphasized that while an offshore complex is being considered to meet future transportation needs, both its benefits and costs are realized and distributed in the future, in a way that is unique for each alternative. The processes of evaluation and choice are made now and must consider carefully the temporal distribution of such effects.

END NOTES

¹For a discussion of the problems and complexities involved, see Horst W. J. Rittel and Melvin W. Webber, "Dilemmas in a General Theory of Planning," Policy Sciences, Vol. 4, 1972, pp. 155-169.

²Sincoff, Michael Z., and Jarir S. Dajani (Eds.), Urban Transportation: Perspectives on Mobility and Choice, NASA Contract NGT 47-003-028, Norfolk, Virginia: Old Dominion University Research Foundation, 1974, p. 29.

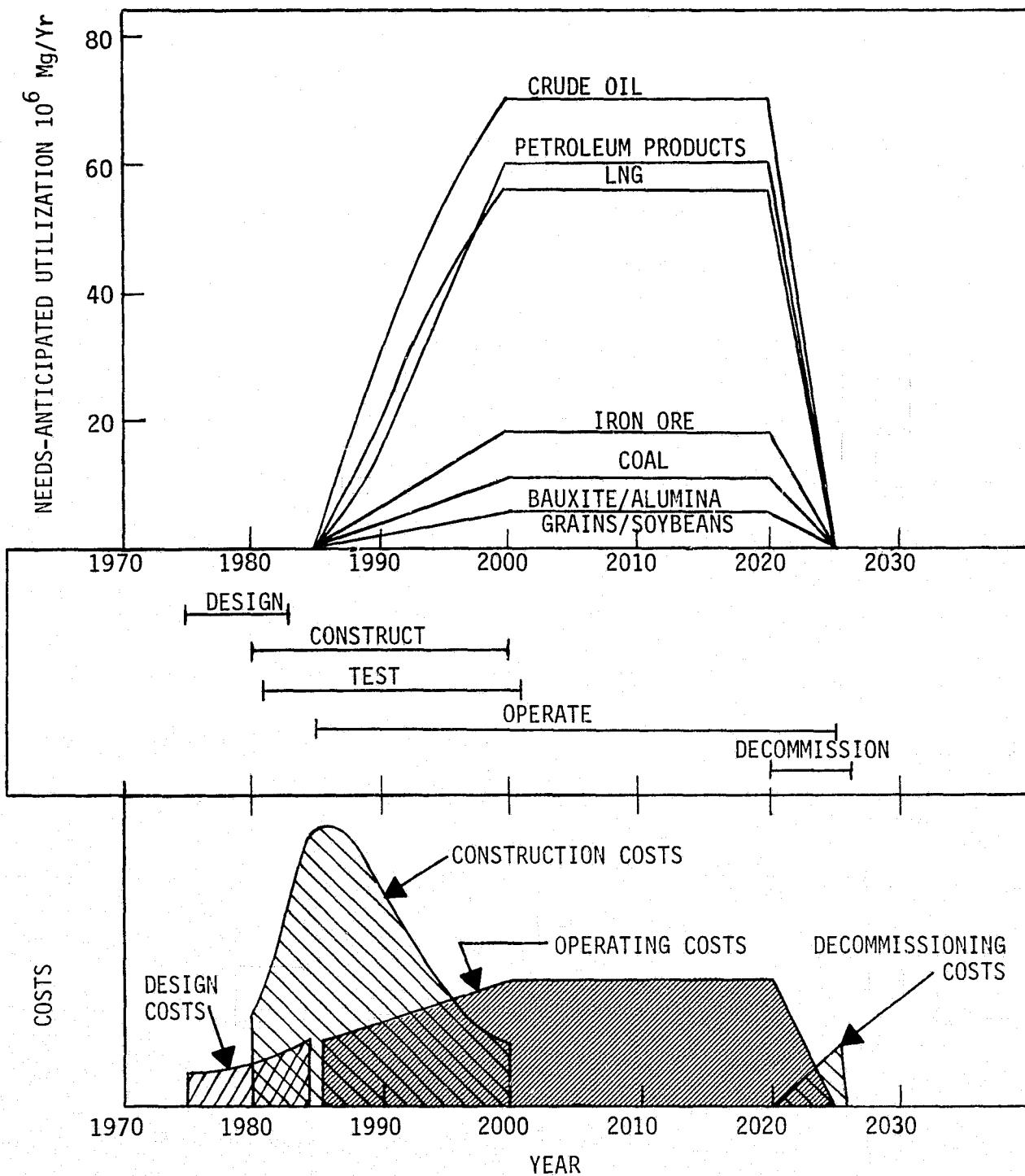


FIGURE 2-4
TEMPORAL EVOLUTION OF PROJECT DEVELOPMENT

³Using symbolic logic, the four alternative ways in which problem (F) can be solved are:

$$F = (a_{11} \wedge a_2) \vee (a_{12} \wedge a_2) \vee (a_{31} \wedge a_4 \wedge a_5) \vee (a_{32} \wedge a_4 \wedge a_5)$$

where (\wedge) denotes a conjunction (and), (\vee) denotes a disjunction.

CHAPTER III
IMPACT ASSESSMENT

Chapter III

IMPACT ASSESSMENT

INTRODUCTION

Impact assessment, as subsumed under the more general heading of "Technology Assessment," seeks to permit the identification of: (1) likely constraints on the newly-introduced technology; (2) impacts which are not likely to be important or controversial enough for further study; (3) project-related impacts which are important or controversial enough to require extensive analysis; (4) alternative designs at an early stage in the planning process to avoid or to minimize the potentially controversial impacts.¹

The underlying philosophy of technology assessment is to be projective, to be able to make some predictions of the potent and sometimes irreversible effects of introducing a new technology before these effects actually appear. It is through the application of a projective assessment rather than merely reaction after the fact that the ultimate benefits of a technological innovation can be realized while potentially undesirable social, political, and economic perturbations of the affected social and natural systems can be confronted and ameliorated.

Whether it is deemed desirable to locate an offshore island complex in one region as compared to another depends, in part, on the impact that the complex will have onshore. To assess this impact, it is necessary to perform a baseline projection of the region without the island complex, and a similar analysis of the region with the offshore complex present. This chapter discusses the possible community, political, demographic, economic and physical-ecological impacts of offshore complexes, and concludes with a discussion of the "Quality of Life": the ultimate objective of impact assessment.

PRELIMINARY SOCIOECONOMIC IMPACT

As a prelude to an in-depth impact analysis, a preliminary assessment of potential socioeconomic impacts should be conducted. The preliminary study is made early in the planning stage of a project and is based on initial location, design and function specifications as well as other available supplemental in-

formation.

For the development of a large scale project such as an offshore complex, a periodic reassessment of socioeconomic impact information is appropriate in order to consider data that are generated as a result of progress on the project. Pertinent information such as the effects of project development on land-based transportation systems, changes in property taxes, and residential activity may not become available until a project is initiated. As these actual impact data become available during the evolution of an offshore complex, they are used to reassess socioeconomic impacts.

The following list presents those data sources which normally will be sufficient for a preliminary socioeconomic assessment:²

- (1) United States Geological Survey (USGS) maps of the study area;
- (2) aerial photographs of study area;
- (3) existing and proposed transportation network and alignment characteristics (type of facility, location, mode), to be overlaid on aerial photographs, land use and other types of maps;
- (4) current and projected traffic volumes and network assignments for each study alternative;
- (5) proposed facility design characteristics--such as the type of construction, area occupied by the offshore complex, physical layout--and approximate cost estimates;
- (6) proposed facility construction features, such as the duration of construction, need for re-routing and requirements for heavy construction or blasting operations;
- (7) master plans for development and capital improvement programs prepared by local, regional or state comprehensive planning agencies;
- (8) land use plans and analyses, prepared by local, regional or state planning agencies and describing both the goals and objectives of jurisdictions in the study area and the existing and proposed future distribution of land and water uses (e.g., residential, commercial, industrial, institutional, recreational);
- (9) building location maps of the study area;
- (10) population density maps of the study area, developed from census data;
- (11) zoning maps prepared by local jurisdictions in the study area;
- (12) employment location and density maps, developed by the regional planning agency or from state economic development agency data;
- (13) economic land and water use development trends (past and projected), developed and mapped for the study area from information obtained at local or regional planning and development agencies, state economic development agencies or utility companies;

- (14) open space and recreation facility maps, depicting present and proposed publicly-owned areas (obtained in data elements 7 and 8 above) and privately-owned areas (obtained from aerial photographs);
- (15) historic and cultural resource lists and maps, including National Register sites as well as sites and resources identified by the State Historic Preservation Officer and local historic associations;
- (16) archeological resource lists and maps, including National Register sites as well as sites identified by or of potential interest to, state and local archeological offices or groups;
- (17) maps of major public facilities (e.g., educational, health care, police and fire protection, water supply, waste treatment), and municipal and state buildings;
- (18) existing and projected transit routes, schedules and patronage figures, obtained from local transit authorities and companies;
- (19) cost/revenue data for each municipality in the study area, relative to fiscal impacts on public facilities and services;
- (20) property tax assessment data for areas within and adjacent to proposed rights-of-way for each alternative, obtained from local tax assessor's office;
- (21) sales data for commercial facilities in the study area;
- (22) income characteristics of residents in the study area, obtained from census data;
- (23) summary of regional labor force characteristics identifying major sectors of employment and skill concentrations in region as enumerated in census data;
- (24) socioeconomic data obtained from the census and locally prepared planning reports which identify the characteristics and boundaries of communities found in the study area;
- (25) summary of relocation resources in the study area for potential residential or business relocatees, obtained from local planning agencies and relocation departments;
- (26) topographic maps, available in the USGS series, showing natural features such as lakes and large rock outcroppings as identified in the USGS series or in aerial photographs;
- (27) soil survey maps, obtained from the Soil Conservation Service;
- (28) surficial/bedrock geology maps, obtained from USGS series or state geological surveys;
- (29) vegetation/wildlife maps identifying general characteristics of vegetation, and wildlife movement and concentration patterns, available from state fish and game agencies and local conservation groups;
- (30) rare and endangered species lists, obtained from Federal, state and local agencies;
- (31) floodway/wetland maps identifying the locations of flood-plains and

- either coastal or inland wetlands in the study area, obtained from the Army Corps of Engineers, USGS, or state and local conservation groups;
- (32) water quality classification maps, obtained from state departments of water pollution control;
 - (33) meteorological data, obtained from Environmental Data Service of the National Oceanographic and Atmospheric Administration;
 - (34) air quality implementation plans, obtained from state or regional air quality control agencies;³ and,
 - (35) bathymetric maps of the adjacent continental shelf.

In addition to the collection of considerable data for socioeconomic impact assessment, specialized professionals should be employed to assist in making impact assessments. Such specialists should be able to enumerate and provide measures to sensitize planners to the different types of socioeconomic impacts. Among types of specialists who might be employed to study the socioeconomic impacts of an offshore artificial island complex are: architects, community liaison personnel, economists, geographers, historic preservation specialists, real estate analysts, relocation specialists, social scientists, transportation planners/engineers, and urban planners.

One should be aware that the employment of any one of the measures above may cause a multitude of different types of impacts. In fact, the employment of a measure to reduce the negative impact of some particular socioeconomic variable may adversely affect other socioeconomic variables.

COMMUNITY IMPACTS

Whenever a technological development occurs, especially the construction of a large offshore artificial island complex, there are bound to be consequences for the community or communities directly involved. Among the effects on community stability and cohesion observed by Raymond Gold in a study of two Montana towns affected by coal industrialization were the following: (1) shifts in the selection of friends; (2) strains in communicating with friends and neighbors of long standing; (3) shifts in the established power structure of the communities; (4) the emergence of a keen interest in some merchants and businessmen in immediate monetary gain; (5) a need to accommodate to the invasion and requirements of newcomers with different life styles and value systems; and, (6) a loss of a sense of community.⁴

Similar studies have demonstrated how technological change has undermined

the traditional, formal, and personal orientations of local residents. Social and cultural disintegration of a community is a very realistic consequence of a too rapid technological change, and in turn results in individual unhappiness, neighborhood blight, and a general and rapid decline in community quality of life.

One final important introductory remark. Impacts can be either positive or negative; simply identifying something as an impact does not decide this issue. For instance, the influx of labor force into a community as a result of a major industrial development may have either positive or negative impacts. One cannot tell if an increase in the community population size is good or bad for the impacted region. In fact, it was the concern with negative environmental impacts which prompted legislation like the NEPA. That the concern is still pressing is reflected in remarks throughout this report; however, the overall intent of it is to encourage as full and detailed an identification of positive and negative social impacts as is deemed appropriate.

Two major areas frequently examined in social impact assessment are (1) community cohesion and (2) community facilities and services. Each of these areas is discussed below.

Community Cohesion

The concept of community cohesion is a useful umbrella under which to examine the comprehensive and cumulative nature of social impacts. The first requirement in examining community cohesion impacts is that of defining the boundaries and characteristics of each community or neighborhood. Unfortunately, there is neither one best definition of community nor a single method for establishing such a definition that is considered to be reliable. Using political or legal boundaries to define a particular community often ignores a resident's personal "sense" of what constitutes a community for him. Psychological perceptions of "community" can be more important than political/legal boundaries in influencing one's life style, values and interaction patterns.

Several techniques nevertheless have been developed for identifying a community's boundaries.⁵ It is often possible to rely upon the subjective knowledge of persons and agencies in the area being examined. Local planning and development offices often conduct detailed studies of neighborhoods and entire communities. This type of information can be useful provided that the findings

are reflective of the attitudes and perceptions of local residents. Where local studies are not already available, it may be necessary to conduct interviews with local officials, businessmen, and residents to define community limits and characteristics.

Another technique employed in defining community boundaries includes examination of physical discontinuities or barriers (e.g., highways, mountains, bodies of water). Although less reliant upon the subjective evaluation of local residents, this technique is more reliant upon inferences made from the researcher's observations. While providing some information on the community's boundaries, this technique tells one very little about community stability and cohesion.

In an attempt to analyze the social interactions which occur within communities, a number of techniques have been developed recently. Most of these techniques require first-hand data collection and may prove to be quite expensive to employ. The Department of Transportation Notebook on Social Impacts describes three such techniques: (1) the neighborhood index; (2) social capacity indicators; and, (3) social interaction analysis.⁶ Among the various sources of secondary data which can be also used in these types of analyses are land use plans; USGS maps; zoning maps; federal, state and local agency reports; labor force characteristics; property tax assessment data; economic land use development trends; building location maps; and, roadway network and alignment characteristics.

Depending on the nature and extent of the impact study being conducted, some of the sources of secondary data above may be unavailable or of little use. Primary data collection may be necessary either to supplement other sources of data, to enhance the reliability and validity of one's findings, or to generate new information. Some typical research strategies used in community impact studies include conducting personal interviews with community leaders, engaging in participant observation, administering questionnaires, and conducting surveys. In most cases, respondents should be sampled randomly to permit generalizations from a representative sample.

In the absence of detail about specific functions to be performed or site location, assessment of the impacts of an offshore complex on community cohesion is difficult. Given detailed information about a proposed project, one

can begin to examine some particular parameters of community cohesion, including measures for interaction patterns and preferences, as well as demographic and ethnic data. These and other forms of data usually require an extensive survey of each impacted community.

An important point to keep in mind is that no matter how sophisticated are the measures one uses to assess these parameters, any assessment of the impacts on community cohesion requires consultation with local residents, community representatives and local officials.⁷ Direct, frequent and informed participation of individuals, interest groups and officials is not only important for improving validity, but is critical for the ultimate success of any project. The involvement of community residents in the planning phase is an effective means for identifying potentially adverse impacts and revising design components which may otherwise engender effective community opposition. A fault of many large-scale projects is that they do not incorporate community participation at an early enough stage. Post hoc involvement often results in polarization and confrontation with exactly the effect on community cohesion that one wishes to avoid.

In attempting to estimate community cohesion, the researcher must be aware of the highly subjective nature of his measurements and treat his findings accordingly. Once identifiable communities within the impact area have been defined, several important questions need to be asked about the effects of an offshore complex. Some key assessment questions which are specific to the various phases (i.e., planning, construction, operations, and decommissioning) of any offshore development include the following: (1) Will the planning and construction of an offshore facility create the need for onshore support facilities, with accompanying demands upon highway, community services, residential areas? (2) Will important areas of a community be isolated, or in any way set off, by construction activities? (3) Will residents be dislocated as a result of the need for onshore support facilities? (4) What effect will the construction process have on the community in terms of air and noise pollution, increased traffic, and the influx of "outsiders"? What specific groups, if any, will be affected the most (e.g., ethnic, age, racial, occupation, or income)?⁸ Also, questions should be asked pertaining to the perceived positive or integrative effects on the community. For example, (5) will the project create increased

community pride because of its potentially unique nature or because of its perceived national importance? (6) Will family incomes be increased because of job opportunities and other economic benefits?

Before questions about the dynamic impacts of an offshore island can be answered properly, a comprehensive picture needs to be derived of communities to be impacted. Baseline data on the current state of a community's facilities, services, and character are the necessary foundation for the assessment of any socioeconomic impacts.

Community Facilities and Services

Some facilities and services in an area which could be affected by the development of an offshore complex include educational, religious, recreational and cultural facilities, as well as public welfare (health and safety), law enforcement and institutional and commercial centers. An inventory of these institutions including their capacities and conditions is essential prior to any detailed evaluation of the socio-political-economic impacts resulting from the introduction of an offshore complex (or any other large scale construction). Table III-I presents an inventory of baseline descriptors of community institutions about which information should be available from sources such as master plans, land use plans, or local planning agencies.

Once demands--both current and projected--on the community institutions and services are determined, the process of assessing potential impacts from an offshore complex can proceed--primary inputs and outputs to and from the offshore complex and any necessary land-based support facilities can be identified, and at least some potential impacts on some of the community descriptors mentioned above should become apparent. By repeating this evaluation several times, with changes in community descriptors becoming the input to further changes, indirect and long-term impacts resulting from the introduction of an offshore complex can be identified.

The assessment process also needs to be made sensitive to the important social dimension of community perceptors. Peoples' perceptions are often more important than community descriptors and carry more implications (political, economic, and others) than the actual reality of the situation. Therefore, a series of attitude surveys, local publication content analysis, participant observations, and/or some other method of evaluating the perceptions of local resi-

TABLE III-I

COMMUNITY INSTITUTIONS: BASELINE DESCRIPTORS

ORIGINAL PAGE IS
OF POOR QUALITY

I. Education (Private and Public)	Maximum Capacity	Age	Condition	Current Enrollment	Projected Enrollment	
A. Elementary and Secondary <ol style="list-style-type: none"> 1. Number and size of school districts 2. Number of schools <ol style="list-style-type: none"> a. Elementary b. Junior High c. High 						
B. Colleges and Universities (2 yr. and 4 yr. institutions) <ol style="list-style-type: none"> 1. Number and location 2. List of undergraduate programs by school 3. List of Graduate programs by school 						
C. Technical and Trade Schools <ol style="list-style-type: none"> 1. Number and location 2. List of training programs and specialties offered 						
II. Religious Facilities	Physical Size	Number of Members	Location of Members	Ethnic Makeup	Type	Size
A. Number of Churches						
B. Religious Community Agencies and Programs						
III. Community Health and Safety	Maximum	Age	Condition	% Utilization	Staff	Projected Use
A. Community Health <ol style="list-style-type: none"> 1. Hospitals <ol style="list-style-type: none"> a. Location (number of beds, staff) b. Specialized units and capacity (e.g., pediatric, intensive care, coronary, eye, etc.) c. Emergency and disaster facilities 2. Outpatient Clinics 3. Physicians and Dentists 4. Community Health Programs 5. Community Mental Health Facilities and Programs 						

TABLE III-I (Cont.)

COMMUNITY INSTITUTIONS: BASELINE DESCRIPTIONS

	Capacity	Number	% Utilization	Projected Use	Projected Incidence	Type	Staff
6. Frequencies of injury and disease by Demographic sub-categories (age, sex, employment, unemployed)							
B. Fire Safety							
Fire Districts							
Specific Facilities (insurance ratings unusual risks)							
C. Public Safety and Law Enforcement							
1. Police Districts							
2. Detention Facilities, Courts							
3. Rehabilitation facilities, programs, halfway houses, etc.							
4. Crime Rates by various categories							
IV. Cultural, Recreational Services	Capacity	Number	% Utilization	Projected Use	Condition	Age	Staff
A. Parks and open space							
Types of facilities							
Specific Waterfront Activities							
Beaches							
Marinas							
Fishing areas							
Nature reserves							
B. Libraries, museums, cultural and recreational centers							
C. Commercial entertainment facilities (movies, bowling alleys, sports arenas, etc.)							

* This Table does not include public utilities (water, sewer, electric, etc.)

dents should be considered. Also, some assessment of the stability of these perceptors should be made.

In the past, there has been a direct relationship between the planning and the construction of a project and alterations in the size and distribution of populations.⁹ Initially, the impact takes the form of an influx of construction workers, who place increasing demands on local services and institutions. In the case of an offshore development, this influx of population is dependent upon the need for onshore construction work applicable either to the offshore facility itself or to necessary supporting facilities.

In some cases, the influx of construction workers and other personnel creates a temporary "boom" situation; however, after the construction phase, demand levels on community facilities and services may decrease, leaving the area with an under-utilized service and institutional structure.¹⁰ This can be a costly tax burden for local residents to bear.

Assessment questions must be asked dealing with (1) modified access to facilities and services; (2) discrimination against particular groups (e.g., ethnic, age, racial, income) in terms of reduced access resulting from "barrier effects"; (3) the provision of alternative and/or additional facilities and services; and, (4) the effect of proposed impacts on loss values and usage levels of the existing facilities and services.¹²

Development of an offshore complex possibly could affect facilities and services in an area by (1) changing or in some way altering the quality of existing facilities and services (this may result from a sudden influx of construction workers and other, perhaps permanent, personnel into the impact area); (2) modifying the usefulness of existing facilities and services (newcomers not only create problems in terms of demands for services, but the nature and extent of services may vary with a significant change in the composition of a local population because of different value systems and life styles; and (3) modifying accessibility to community facilities and services.

The extent of impact on the community's facilities and services depends on the number of people brought into the area during the planning and construction phases of a project, and how many then become permanent residents. Often the most difficult questions concern the impacts on facilities and services once, and if, the project is decommissioned and people migrate out of the area.

Several analysis techniques have been employed to identify patterns of movement to and from community facilities and services.¹³ These techniques, which appear to be more useful in urban areas than in rural or suburban areas, are designed to identify major access routes (local streets and major arterials) and community facilities such as stores, schools, churches, and recreational and cultural centers. By using interview and sample surveys data, trip origins for each activity can be plotted on a base map. Origin-destination maps for each activity are then combined to show concentrations of travel to and from various facilities and services.

On a regional basis, various indices of accessibility can be employed. For example, the accessibility of one particular area to another is sometimes expressed as a function of the attractiveness of one area and the spatial separation between the two areas.¹⁴ The costs incurred by increased travel are offset by the increased perceived benefits gained from the more attractive facility.

A technique known as isochronal mapping can be used to identify all origins located at specified time intervals from a particular facility or service, depending on alternative modes of transportation and times of the day. This analysis can show changes in accessibility to facilities and services as well as potential changes in land values and development trends.¹⁵ Accessibility isochrones can show exactly how long it takes (at specified time periods) to travel from various sections of a community to a specified destination. These maps can be constructed from base-line data for current transportation systems, as well as from estimates of future travel times for proposed systems.

Which of the various analysis techniques is used depends on the nature of the proposed project. If major disruptions or alterations are anticipated in accessibility to community facilities and services on both a local and a regional basis, one is more likely to use accessibility indices or isochronal maps. In general, origin-destination maps for individual activities are more useful on a local level.

The outcome of changes in community facilities and services is felt ultimately in the political system. In addition, the political system can sometimes circumvent or even prevent potentially undesirable impacts from a new technology. Therefore, an assessment and mapping of relevant political systems is also important.

POLITICAL IMPACTS

Just as it is important to isolate social and economic institutions which can be impacted potentially by the introduction of an offshore complex, an understanding of the relevant political institutions involved and affected by such a development also can be critical. It would be critical not only to those proponents or opponents of a potential offshore complex, but also for an overall understanding of those political institutions which can affect or be affected by offshore developments.

The importance of public participation from the early planning and design phases to the operation and decommissioning phases has been alluded to earlier. At this point, a mapping of political institutions relevant to potential impacts is presented.

The objective in mapping these governmental and non-governmental institutions is to present in as concise a manner as possible those bureaucracies and interest groups with direct involvement in decision-making affecting the offshore environment. Once identified, their jurisdiction, participation and efficacy can be compared. Table III-II presents a framework which, when details are filled in, will yield a comprehensive and yet concise overview of those political actors and organizations which may at some point be involved. The cells of this framework can be filled in through a combination of historical analysis; interviews with government, business and community leaders; consultant expertise; bureaucratic publications; newspaper accounts; and organization records.

Through the examination of these institutions, their functions, their major actors, the processes by which they operate, and the effects they eventually produce leads to a technology assessment that will be far more responsive in evaluating those impacts having potential to result in unpleasant political repercussions. Performance of even this rudimentary assessment of political actors would enable better projection about what political responses would directly occur as a result of the construction of an offshore complex, and perhaps the potential political implication of indirect social, economic and physical impacts.

DEMOGRAPHIC IMPACTS

From planning to decommissioning of the offshore complex, there will be

TABLE III-II

SCHEME FOR RELEVANT POLITICAL MAPPING (WITH SELECTED EXAMPLES)

	Institutions	Functions	Specific Actors	Processes	Effects
I. International	A. Intergovernmental Organizations	IMCO (Intergovernmental Maritime Consultative organization)	Coordinate and formulate international laws and recommendations affecting ocean shipping	Legal committee, maritime safety committee, Secretary General, etc.	negotiation, International Conferences, regular meetings, Nations voting on proposals, etc.
	B. Non-Governmental Organizations	Oil Companies International Marine Forum	coordinates industry policies regarding government actions affecting oil tankers	Exxon, Shell, American Petroleum Institute etc.	Regular meetings, participation is as an officially recognized NGO in Intergovernmental activities
II. National	A. United States Government Departments, Agencies	Department of Commerce	Administers, regulates and facilitates all federal activities regarding American Commerce	Secretary of Commerce, National Oceanic and Atmospheric Administration etc.	Enacts detailed regulation carrying out Congressional legislation supports scientific activity in the oceans, etc.
	B. Nationally active private interest groups	AFL-CIO etc.			Managed effective Sea Grant Programs, many American shipping firms depend on Maritime Administration subsidies, etc.
III. Regional	A. Multi-State Agencies and working groups	etc.			
	B. Private	etc.			

TABLE III-II (Cont.)
SCHEME FOR RELEVANT POLITICAL MAPPING (WITH SELECTED EXAMPLES)

	Institutions	Functions	Specific Actors	Processes	Effects
IV. State					
A. State Govt. Depts. and Agencies					
B. Private					
V. County and Local					
A. Government					
B. Private					

direct and indirect impacts on the demographic character of onshore locality near the construction site and on the surrounding region. Uncertainty is inherent in efforts to forecast these effects, and periodic review and re-estimation will be required to update data relevant to the project.

One analytical method to study the impact on the population characteristics of the impacted areas is to compare the area with and without the offshore facility. Figure 3-1 shows the outline of a general method of analysis. Basically, the three steps involved are to:

- (1) project census-type base data and/or to simulate the populations at some future date;
- (2) estimate the additional social and physical support facilities needed by the new populations (e.g., schools, hospitals, police manpower, water supply, solid-waste disposal); and,
- (3) compare the population situation with the project versus the case without the project.

Figure 3-1 also contains a column labeled Alternatives A, B, C These alternatives include all the ways known to achieve the same end as the offshore complex (e.g., fully offshore, fully onshore, or some combination of onshore and offshore). As many of these alternatives, as time and money permit, should be included in a comparative analysis.

The demographic impact analysis should be done at a very early stage in the life of the project. To facilitate the analysis, the stages in the life of the complex have been added to the right-hand side of Figure 3-1: (1) Planning; (2) Relocation; (3) Construction; (4) Operations; and (5) Decommissioning. The total life (stages 1-5) of the initial function(s) of the offshore complex (i.e., not the life of the "island itself") is assumed to be 40-50 years. In the next chapter it is shown that the combined planning and construction stages (including the relocation stage) could take 20-25 years to complete. The total life of the facility is assumed to be twice the length of planning through construction time.

Prior to the relocation stage, a certain population will be living in the mainland area which will be affected by the new offshore facility. Base population data are available from the United States Census Bureau. Population counts are available by region, state, county, minor civil division (MCD), enumeration district, census tract, and block. Census data also contain breakdowns by age, sex, marital status, race, ethnic origin, rates of births and

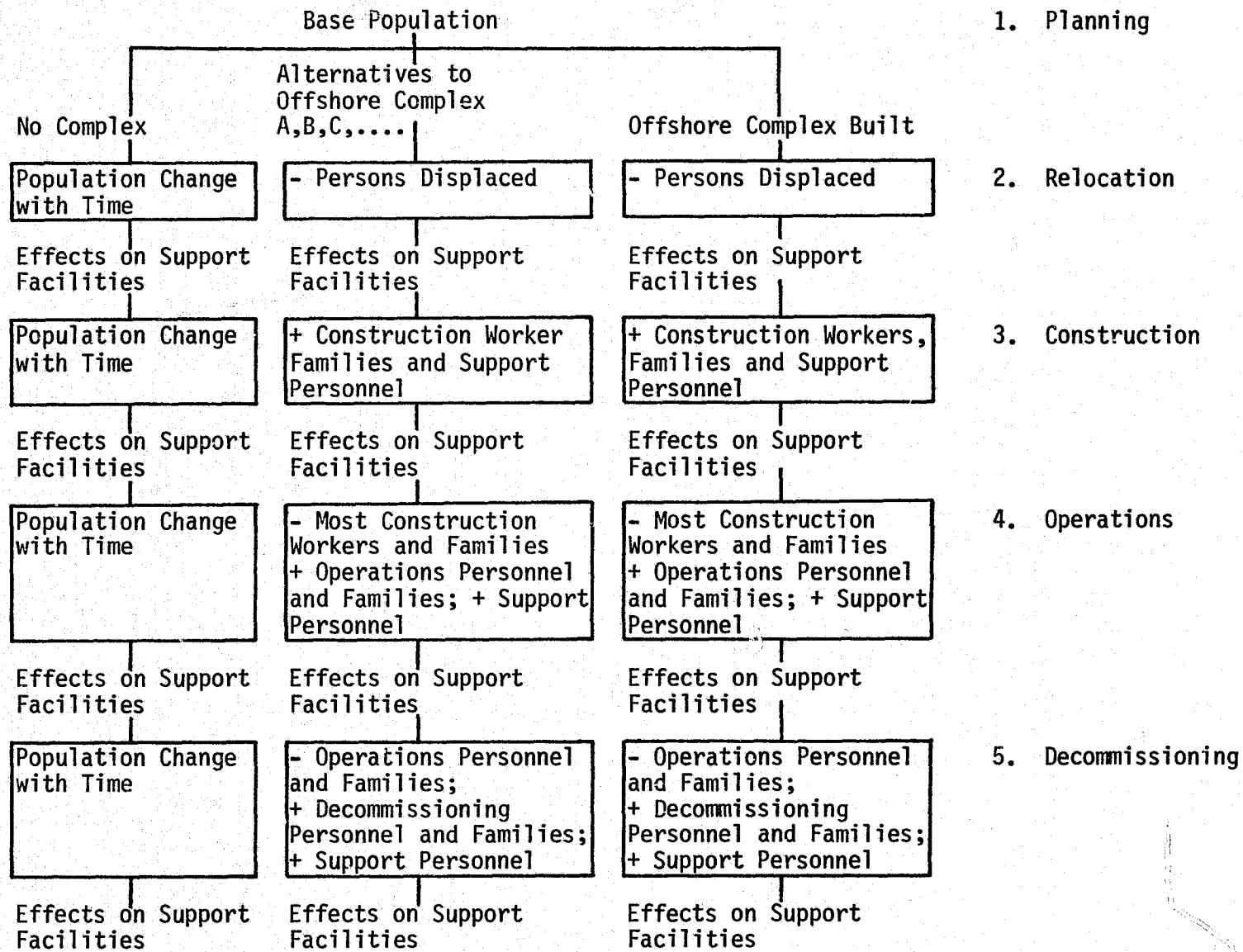


FIGURE 3-I
DEMOGRAPHIC SIMULATION MODEL FLOWCHART

deaths, migrations, etc., down to the state level. Municipal and other governmental organizations may have other vital statistics at levels useful in the analysis.

For the left-hand side of Figure 3-1 some population forecasting technique is needed, yet population forecasting beyond 10-15 years is a difficult task, especially at the levels which may be required for the study of an offshore complex. An approach to long-range projection below the county level is given in a manual prepared by Greenberg, Krueckeberg and Mautner, who have provided both traditional and novel methods for projecting population at the MCD level. The traditional method involves a direct step-down technique (examining successively smaller geographic areas) from the Bureau of the Census cohort-survival analysis (population projections by age and sex groups) at the state level. This is done by examining each county's and MCD's historical share of the state's population; the historical share is then extrapolated to the projection period. One novel method of population projection attempts to link population change to some "market force" such as zoning, the location of transportation centers, and the development of non-residential land use. In actuality, Greenberg, et al. have combined the step-down and cohort-survival techniques with a model developed by Newling which tries to relate population changes to trends in suburbanization.¹⁷

Once the population projections/simulations have been made for the "no-offshore complex" alternative, the calculation of the support facilities for this new population can be made. A study done by the Commonwealth of Virginia used the following ratios for such calculations¹⁸:

School enrollment	262.5 per 1,000 population
Hospital	3.64 per 1,000 population
Police Manpower	1.53 per 1,000 population
Government Overhead	\$7.53 per person
Government Employees	30.0 per 1,000 population
Water demand - Domestic	100.0 gallons per person per day
Water demand - Industrial	Refineries - 40 gallon per barrel Gas Processing - 15,000 gallons per plant
	Petrochemical 24 million gallons per day per plant
Sewage domestic	100 gallons per person per day
Solid Waste	3 tons per 1,000 population per day
Residential structures	3.0 persons per household
Commercial structures	24.5 square feet per person

These ratios will vary from place to place, and a set consistent with the offshore complex location should be used.

The cases of alternatives A, B, C . . . and the building of the complex (the right-hand side of Figure 3-1) can be considered together. The building of any facility, whether offshore, onshore, or combination thereof will bring about changes in population numbers and structure and in existing support facilities. These changes will be different in type and magnitude depending on the stage of development of the facility. Obviously there are no fast and sure methods for estimating these changes. Simulation techniques could be used, but rough calculations may be sufficient.

A storage and staging area might be needed near the building site at sea. (There is also the possibility that the complex can be assembled somewhere else and towed to its permanent site.) If construction is done in situ, persons may have to be relocated from the land area selected as a support base. Once some knowledge of the dimensions of the complex is available, an estimate of the land area needed can be made. Then an estimate of the numbers and kinds of people displaced can be attempted. The differences in the numbers and characteristics between not building the complex and building it (or alternatives A, B, C. . .) are equal to the impacts of the facility on the population of the area.

The next stage is the actual construction of the offshore complex. It is assumed that the person doing the analysis knows the general dimensions of the structure and that construction will take place in situ. Again, some estimate will have to be made of the population changes which will be brought on by the construction of the complex, and this estimate will have to be compared to the no complex projection.

To help make these estimates, one can turn to a feasibility study of a similar project, such as the proposed New York offshore airport.¹⁹ The consultants who wrote that report thought that the construction stage would last about ten years. The offshore labor force for the New York airport study was estimated to be between 100 and 1,000 in year two, rising to a maximum of approximately 3,000 during the fourth and fifth years. The labor force was to fall off from under 2,500 at the end of year five to about 1,700 at the end of year six, to somewhat over 1,000 at the end of the seventh year to 100 or so at the end of

year ten. The time span for construction and the number of workers for the New York offshore airport study might have some general validity for projects of this sort and could be used to structure the simulation model.

If the workers live in the vicinity of the construction site, the major impact of the project will come during the construction stage and will be felt in the communities surrounding the site. Using census data to estimate the number of persons in each worker's family, simulation techniques might be helpful in determining demand for housing, schools, sewer and water needs, new highway construction and support personnel (such as teachers, doctors, etc.).

The operations stage, which may last 25-30 years, will witness the out-migration of most, but not all, of the construction workers. A smaller, differently trained personnel group will be needed to operate the complex. Estimates will have to be made of the composition of this population and of its basic needs.

The decommissioning stage of the original function will see yet another population enter the area as the offshore complex is razed or modified for some other use. It might be converted into a station to aid the colonization of outer space or the ocean bottom, it might be sold for scrap, or it might become unused like Ellis Island. Some estimate of the characteristics of the decommissioning population will have to be made and compared with the "no-complex" situation.

ECONOMIC IMPACTS

The results of the preliminary socioeconomic assessment should include a list of economic variables to be studied in detail. Such detailed studies will include economic baseline projections (i.e., without the offshore complex) and projections with the offshore complex. As a guide in performing the regional baseline projections, the method used by Arthur D. Little, Inc., is worthy of note.²⁰ Regional projections, assuming the presence of the complex, are based on the Arthur D. Little methodology and that of the Department of Transportation's Environmental Assessment Notebook Series.²¹

Business Activity and Employment

In performing the economic regional baseline study, it is suggested that the analyst rely upon published economic forecasts for the geographical region under consideration. The Bureau of Economic Analysis (BEA) is a major source

of state and regional projections of economic variables. Also recommended are the services of County Planning Boards and other governmental agencies on both the state and regional levels. This section presents a summary of selected economic indicators and suggested measurement and projection techniques for each.

It is suggested that the industrial sector classification system use the definitions adopted by the Office of Management and Budget. This suggestion follows from the fact that most federal, state, and local agencies use this classification scheme, making data comparisons relatively easy. Sectors included in this system are:

- (1) Agriculture and mining
- (2) Construction
- (3) Manufacturing
 - a. paper and allied products
 - b. chemicals and allied products
 - c. petroleum refining
 - d. rubber and plastic products
 - e. stone, clay, and glass products
 - f. primary metal industries
- (4) Transportation
- (5) Public utilities
- (6) Services

Earnings: To project employee earnings and industry payrolls, it is necessary to generate a base year profile for each sector described above. The major data sources for compiling this profile include Employment and Earnings (United States Department of Labor), and the Survey of Current Business (United States Department of Commerce). These documents can be supplemented by County Business Patterns, the most recent data from the Census of Population, and the Census of Manufacturers.²² Long-term projections of earnings can then be derived by using the BEA forecasts and by applying productivity indices to the base year profiles. Productivity changes can be derived through extrapolating past trends. It is imperative, of course, to correct these extrapolations for historical changes which will not be present in the future.

Projected earnings can be calculated once the operations scale of each of the island tenants is known. Employment levels for the tenants would certainly be one of the variables defined in preliminary operations plans. Earnings for the supplier-related industries and those industries affected by the induced effects can then be estimated by use of the payroll/sales ratio (see value of production subsection). Total personal and per capita income can then be fore-

casted by using the income/earnings ratio.

Income (earnings, plus other non-payroll forms): Base year profiles of total and per capita income can be derived from BEA data and the Survey of Current Business. When these income values are compared with earnings data, an income/earnings ratio can be generated.²³ This ratio will indicate the differential between earnings and income. To calculate the projected regional personal income, the previously derived forecast of total earnings is multiplied by the income/earnings ratio. Future regional per capita income is found by dividing the regional personal income projection by the forecasted total regional population.

During the construction phase of an offshore island complex, it is necessary to estimate the revenue streams produced by the construction industry and the producers of island capital equipment. Similar estimates are desired for employment and earnings (of the primary offshore complex tenants) during the operations phase. Valuation of these primary variables will lead to an examination and quantification of a second level of supplier-related production, employment, and earnings for those industries supplying the inputs to the island tenants. Finally, the employee earnings generated by the primary and secondary impacts will themselves induce greater consumer spending; this "induced effect" will lead to additional rounds of impacts on production, employment, and earnings. Multiplier and accelerator models, which take these effects into account, are readily available for use by the analyst.^{24,25}

Employment: Again, it is necessary to generate a profile of base year employment for the sectors above. Employment and Earnings and County Business Patterns are useful data sources, along with regional information available through state and local agencies. The long-term employment projections can then be generated from industry payroll data and earnings per employee. It is noted that these projections should be checked, and modified if necessary, against past regional development trends.

Employment levels for the primary offshore complex tenants are a function of the size and technology of each island operation. Projected future employment levels should take into consideration productivity increases, which may cause employment levels to decline over time. Supplier-related and induced employment can be calculated by dividing the estimated annual wage per worker into

the forecasted total payroll earnings for each industrial sector. In estimating the annual earnings per worker over the forecast years, the analyst must also estimate rates of productivity changes for each industrial sector.

Value of Production: Base year data for the sectors can be obtained from the Annual Survey of Manufacturers (United States Department of Commerce) and the Survey of Current Business. Arthur D. Little, Inc., has suggested two methods of generating the long-term projections of value of production.²⁶ The first method derives a payroll/sales ratio for each industry and then utilizes the forecasted long-term earnings data (developed earlier) to forecast the future sales component of the ratio. The second method simply takes the base year production of each sector and combines these data with forecasts of annual percentage growth. Both methods utilize local historical trend rates of value of production as an indicator of the need for regional adjustments in the forecasts.

The value of production of the primary island tenants can be determined by initial plant size and projections of future expansion. Projections of supplier-related production can be generated utilizing the United States Department of Commerce input-output tables. Using these tables, it is possible to calculate the marginal increase in output of all other industrial sectors, given the output levels of the primary tenants. With knowledge of the region's industrial base, an estimate can be made of the amount of the supplier-related expansion expected in the region under study. Finally, the regionally induced impact of higher consumer spending can be estimated using information on "the commuting pattern of the labor force and the diversity and development of the area's economic base."²⁷

Residential Activity

Closely associated with the island's impact on business activity, employment, and income is its impact on residential activity. The task is to convert island-induced employment gains into changes in gross housing demand, which is a function of the following variables:

- (1) The number of [island] induced employment opportunities;
- (2) The employment participation ratio (the percentage of the total population gainfully employed);
- (3) Average household size (the average number of persons per household).

The analysis technique can be expressed in terms of the following equation:

$$D = \frac{E(1/P)}{H}; \text{ where:}$$

D=incremental gross housing demand

E=island induced employment gains

1/P=the reciprocal of the employment participation ratio

H=average household size

The analysis technique involves a step-by-step conversion. The number of estimated new jobs induced by the [island] is converted into population gains by multiplying the number of [island] induced jobs by the reciprocal of the employment participation ratio. This represents the total population which may be drawn to the region by increased employment opportunities. The population increment is then divided by average household size to translate population into the number of households--the effective unit of housing demand.

The inputs to the formula should be adjusted to reflect the likelihood that resident population components--within or outside the existing labor force--would fill a portion of the new jobs. This housing demand increment could be accommodated in both new and existing housing units. . . .²⁸

The regional planner is concerned not only with forecasts of gross increases in housing demand, but also with the question of where this residential development will take place. The decision-making process of a household, when choosing a home site, concerns a valuation of many utility-producing criteria. A set of primary predictors indicative of whether a particular neighborhood will be chosen for household location would include:

- (1) The existing settlement of that neighborhood and the presently observed settlement pattern there;
- (2) The number of suitable vacant development sites in that neighborhood;
- (3) The cost of reaching, or being reached from, those places that must be accessible on a daily basis. This cost is most commonly measured in units of travel time by the predominant mode of transportation. Sometimes more elegant cost functions are formulated to include travel time, money cost, measures of comfort, reliability, and even social status of available travel modes;
- (4) The actual purchase or rent cost of the available sites, as viewed in the context of the potential user's resources and his alternate options.²⁹

There exist ample land-use models which incorporate some or all of the above-mentioned predictors (particularly, the descriptive summary by Walter Helly of several of the best-known land-use models, all specialized to the residential site prediction problem).³⁰

Property Value and Taxes

That the construction of an offshore complex can affect onshore property value and taxes is of concern, since the taxes represent a primary source of

revenue for most local communities. Land values, and thus property taxes, can be affected directly and indirectly by the establishment of shore-based support facilities for an offshore complex.

One direct effect on property taxes would be the in-migration of the new labor force and families demanding housing and other community support services. As long as housing is not overbuilt, property values should increase as should tax revenues, although one should expect a decrease in property values for a short time should overbuilding take place.

Indirect effects on property values and tax revenues are difficult to access. If one examines "spillover value," for example, a facility that is aesthetically pleasing can have positive effects by enhancing the values of adjacent properties. This positive spillover is difficult to assess. Negative spillover effects such as air, noise, or visual pollution that cause decreases in property values hence decreases in tax revenue. Unfortunately, estimates of decreases from negative spillovers are as highly subjective as are positive effects. To the extent that spillover effects will occur in a given project, and because of the subjectiveness of the estimates of the effects, their effect on property values should be estimated in consultation with realtors, appraisers, land use planners and other persons knowledgeable about local land values.

In addition to determining which property values are affected and by how much, the temporal attribute must be considered. For example, one must project how long it will take for changes in real estate values to be reflected in assessed values and property tax yields. The problem is complicated further as the functions of the shore-based support facility change during the pre-construction, construction, and operation phases. During these phases, there will be changes not only in assessed values but also in indirect spillover effects.

After effects on property tax revenue have been assessed, changes in net public expenditure should be estimated. This is a very difficult task since the cost of these public service requirements are contingent on specific location and their development pattern. The Department of Transportation's Environmental Assessment Notebook Series³¹ has recommended that "since the public service requirements of commercial and industrial development exhibits the most pervasive public service requirements, the assessment should be confined to residential service requirements."³²

Based on the comments above and sustained by the detailed analytical scheme presented in the Environmental Assessment Notebook Series, it is recommended that one use residential service requirement data to perform public service requirements assessment.³³ The method of estimating incremental public service requirements is by examining present and planned public service requirements as well as capacities. Typical public service activities which may have to be augmented in the future as a result of island-induced activities are schools and municipal services such as electricity and sewage facilities.

Some impacts which may be experienced by a community as a result of the development of an offshore complex are increased congestion onshore and offshore and increased air and noise pollution. Such impacts may eventually have some effect on tax expenditures. This could occur if a community decided at some later date to expend tax money to alleviate some of the negative impacts of an offshore complex. Such impacts are really costs experienced by the local community, but which are very difficult to evaluate in monetary terms. Nevertheless, it would be appropriate to attempt a comparison of tax derived benefits of an offshore artificial island complex with its associated costs. It is suggested that the following types of data could be collected to perform the assessment of benefits (revenues) and costs (taxes):

- (1) land/water use or public facility maps;
- (2) land-based requirements in area;
- (3) island complex functions, size and approximate cost;
- (4) replacement land costs;
- (5) noise and air pollution constraints;
- (6) municipal services costs as a function of the number of customers served; and
- (7) estimates of labor influx into community.

Regional and Community Plans

Just as an offshore facility has effects on property values and taxes, it can also have wide reaching effects on regional and community plans and growth. The considerations presented in this section are applicable not only to the development of an offshore complex but also to any large-scale construction project such as a regional airport, dam, or interstate highway. Such major facilities will not only impact a community's tax base, and thus its fiscal capability to provide public services, but might also influence its power and

goal structures.

The specific proposed plans and programs of each agency in the impacted region should be delineated to ascertain areas of conflict and consistency between the island complex, objectives, effects, and existing/proposed regional plans. This may be accomplished by examining the island development from the point of view of the impacted community, to determine if the island complex will result in:

- (1) considerable environmental impact;
- (2) unbalanced land/water transportation systems;
- (3) unbalanced settlement patterns; and/or
- (4) inadequate delivery of municipal services.

Once such data have been collected and organized, they should be used to determine whether, and how, the island facility will affect both the planning proposals and the identified goals of the impacted regions, agencies, and organizations. Some impacts will be evident whereas others will require considerable effort to discover.

A detailed methodology capable of being used in determining effects of off-shore complexes can be found in the Department of Transportation's Environmental Impact Assessment Notebook Series.³⁴

PHYSICAL-ECOLOGICAL-IMPACTS

Environmental impact statements (EIS) and assessments (EIA) have come into being as a result of passage of the National Environmental Policy Act of 1969 (NEPA). Impact assessments and statements, however, serve different purposes. An EIA provides for intra-agency review of project impacts and is designed to provide adequate information toward determining whether a detailed EIS is necessary. The latter is an in-depth analysis of the environmental consequences of any proposed project. If an EIS is required, it must be reviewed first by the federal agencies involved and then submitted to the Council on Environmental Quality (CEQ) before federal approval is granted. This is especially critical if the project is controversial for environmental reasons or judged to have a marked effect on the quality of human environment.

Thus, any major new installation in which the federal government is involved through regulatory or funding considerations requires an environmental impact assessment. If the federal agencies are required to prepare or have pre-

pared environmental impact statements, the purpose is to evaluate what effects a given project will have on the quality of the environment. Federal agencies, tempered by some court decisions, have developed procedures pertinent to the preparation of environmental impact statements. The CEQ has also developed certain guidelines on uniform procedures and steps in the preparation of these impact statements. These guidelines indicate what is desired in terms of the scope of the investigations, but they do not always meet various technical objectives.

Although NEPA and legal and federal agency interpretations of its intent have led collectively to an enlightened treatment of major projects and their environmental impacts, there exist two significant areas of deficiency in performing environmental impact assessments. The first deals with the various methodologies which are now evolving in this field. An inherent difficulty rests in establishing the comparative value of the different approaches and in selecting that methodology which is best suited for a given project. A related issue is the tendency of environmental impact assessments to be concerned more with quantitative data gathering than with assessments, predictions, and qualitative evaluations.

A second area of concern involves the difficulty of accurately forecasting the future impacts of a project such as an offshore island complex. This is due to the inability to acquire all pertinent data needed to make such forecasts and to understand the entire range of interrelationships within affected ecosystems. The latter situation is largely a result of the scarcity of comparative studies which evaluate the accuracy of pre-project predictions against post-project findings.

These problems are compounded when the project in question is based upon a technology or a combination of technologies for which limited impact data exist. Such would be the case, for example, for a technology which has not been instituted to date. The focus of this report, namely integrated offshore transportation/energy island complexes, may well fit this description.

Physical-Ecological Considerations

In considering an offshore island complex, the following five geographic contexts must be viewed as susceptible to various impacts: (1) the oceanic water in which the complex either will be built (permanent construction site) or floated; (2) the atmosphere which may be affected by functions performed on

the complex; (3) the seafloor which may support the complex or otherwise be influenced by its presence; (4) the effect of the complex on shoreline processes; and, (5) those areas landward of the shoreline which may be affected either by activities on the island complex, ancillary support facilities or onshore activities related to its operation.

Table III-III shows a list of the principal physical, chemical, and biological considerations needed to assess the impacts of an offshore complex, together with the geographic contexts with which these considerations are associated.

The difficulty with such a list is that although most of the considerations included are suggestive of potential impacts, their lack of specificity render the use of the list for predictive purposes quite difficult. To rectify this problem, a sample approach, based upon several fundamental physical and chemical variables, is also represented herein. The approach is predicated on the fact that a natural environment can be described by three sets of state variables: (1) motion; (2) distribution of materials; and, (3) temperature. Motion might be that of air (wind), solids (earthquakes, landslides), or liquids (oil spills, rain). The distribution of materials makes its greatest influence upon biological systems. Included under this category might be such topics as the concentration of certain chemical elements or the configuration of a beach measured in terms of the number and distribution of sediment sizes per cubic centimeter. The third factor, temperature distribution in nature, is probably the most straight forward.

The impact cycle (Figure 3-2) starts by a "disturbance" caused by the introduction of a major facility such as an offshore island complex. Any one or more of these three sets of state variables may be directly affected. The creation of the island itself represents a redistribution of materials, which in turn affects the motion patterns of ocean water surrounding the island, through the diversion of currents and waves. Changes in the materials distribution pattern also affect the natural biological processes. Should the island have a thermal effluent, such as cooling water from a power plant, the temperature distribution in the ocean is bound to be altered. This in turn may affect the water circulation pattern in the vicinity of the complex. These modifications may further alter the distribution of materials through changes in the rate of sedimentation, changes in motion, material distribution, and/or temperature;

TABLE III-III
PHYSICAL-ECOLOGICAL IMPACT CONSIDERATIONS

	Areas of Geographic Incidence				
	Ocean Water	Sea-floor	Shore-line	Onshore	Atmosphere
I. Physical Considerations					
A. Waves					
Sea	X	X	X		
Swell	X	X	X		
Tsunami			X		
Storm Surge			X		
Tides			X	X	
B. Wind					
Prevailing	X	X	X	X	
Storm	X	X	X	X	X
C. Currents					
Wind	X	X	X		
Wave	X	X	X		
Tidal	X	X	X		
River	X	X	X		
Geostrophic	X	X	X		
D. Sediments					
Suspended	X	X	X	X	
Transported	X	X	X	X	X
E. Seismic Potential					
F. Sinkholes--Liquifaction			X		X
G. Landslides		X	X	X	X
H. Ground Water Aquifers			X		X
I. Topography--Bathymetry			X	X	X
J. Humidity--Fog and Visibility					X
K. Temperature	X		X	X	X
L. Atmospheric Inversions					X
M. Salt Spray					X
II. Chemical Considerations					
A. Salinity	X	X	X		
B. Trace Metals--Elements		X	X		X
C. Radioactivity Levels		X	X		X
D. Biologically--Active Compnds	X	X	X		

TABLE III-III (Cont.)
PHYSICAL-ECOLOGICAL IMPACT CONSIDERATIONS

	Areas of Geographic Incidence				
	Ocean Water	Sea-floor	Shore-line	Onshore	Atmosphere
E. Organic Matter	X	X	X		
F. Pollutants					
Hydrocarbons				X	X
Pesticides--Herbicides	X	X	X	X	X
Sulfur Oxide			X		X
Nitrogen Oxide			X		X
Photochemical Oxidants	X		X		X
Odors					X
Particulate Matter	X		X		X
III. Biological Considerations					
A. Biological Productivity					
Nutrient Levels	X		X		
Organic Matter	X	X	X		
Estuarine/Lagoon Food Webs	X		X		
B. Lower Phylogenetic Groups					
Phytoplankton	X		X		
Zooplankton	X	X	X		
Marine Plants		X	X		
C. Invertebrate Fauna					
Benthic Forms	X	X	X		
Nektonic--Planktonic Forms	X		X		
Insects			X	X	X
D. Vertebrate Fauna					
Benthic Forms		X	X		
Nektonic Forms				X	
Fish	X	X	X	X	
Reptiles	X		X	X	
Mammals	X		X	X	
Birds	X		X	X	X
E. Other					
Airborne Biological Elements (pollen, etc.)				X	X
Endangered Species	X	X	X	X	X
Commercially Impacted Forms (fish, shrimp, lobster)	X	X	X		

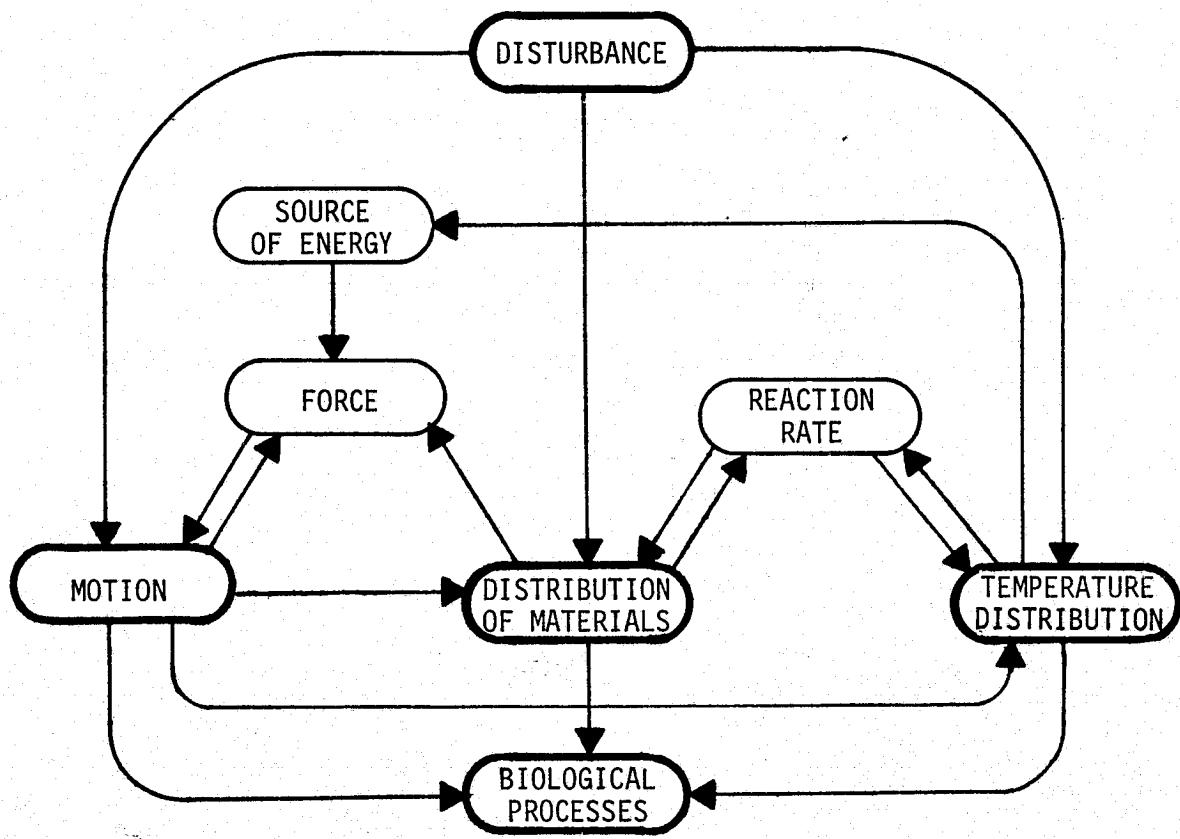


FIGURE 3-2
PHYSICAL-ECOLOGICAL IMPACT CYCLE

thus all have an effect upon the survival of organisms and the biological processes which function within ecosystems.

The simplified examples described above underscore the need in environmental impact assessment to isolate and organize those variables and relationships warranting detailed analysis. Another major problem in impact assessment is that of forecasting future changes and predicting probable future states. Predictive capabilities and techniques are the subject of the following section.

Prediction

The physical-ecological impact of a project is defined as the difference between the environment as it evolves with the project and without the project. At some time before construction of an offshore complex would commence, if the decision is made to proceed with it, the state of the environment is determined. This is referred to as the baseline state. The physical, chemical, and biological processes involved in the evolution of the environment are then used to predict the state of the environment at a later time, both with and without the offshore complex. Comparisons are then made between the two predictions in order to determine the physical/ecological impact of the offshore complex. Finally, a set of objective criteria is used to measure the economic/social consequences of the physical/ecological impacts determined. There are several important questions related to the procedure outlined above which are discussed next in more detail.

The first such question relates to the temporal nature of the impacts and consequences of a given project. The impact is obviously a function of time and must be treated as such. There may, however, be cases in which a steady state impact is reached, i.e., the differences in the physical, chemical, and biological variables with and without the project may become stable after some time. In such cases, this steady state is the logical point at which to evaluate the final impact. Cases in which a steady state is reached are expected to be quite rare, because the environment is continuously and spontaneously changing, and because further change is bound to result from almost any project. In those cases for which no steady state is reached, a decision will have to be made as to the time scale to be used and the differential weights to be applied to different events occurring over time, i.e., the discount rate that society is willing to apply to future events. For example, the effect on the environ-

ment, one million years from now, of any major project may be considered to be of little interest in our present time frame. The time frame generally used does not go beyond several generations. The actual selection of time frame depends, among other things, on man's ability to forecast the future: a very difficult undertaking with present predictive techniques.

The second point related to the effect of a project is the random nature of its impacts. The processes involved in the change of physical, chemical, and biological variables of the environment are, as man sees them now, probabilistic in nature. This means that many of the variables involved in the processes can be defined only with a certain probability. For example, the process of changing the shape of a shoreline is the result of wave action leading to the transport of sediments both offshore and along the shore. In part, this process depends on the wave period, the deepwater wave direction, and wave height. The largest shoreline changes may result from a single storm which occurs with a certain probability during a given year. This means that the predicted future shape of the shoreline depends to a large extent on the occurrence of discrete (yet random) events, or in this use, storms. The prediction either includes such events or does not. There are, therefore, many different predictions which can be made about the nature of the future shoreline. Even assuming that the predictive techniques and the probability distributions used are correct, it cannot be said that any one of these predictions is more correct or accurate than any other, although some will be closer to the probable state than others.

Current Impact-Assessment Methodologies

In the early stages of environmental impact assessment, one obstacle was the lack of methodological tools. Recent attention to this problem has resulted in development of several methodological approaches. Methodologies have evolved according to a desire to have an orderly process for approaching environmental impact studies, but the decision as to whether a particular methodology satisfies a user's desired needs still must be made. Thus, there is no best methodology that one may use exclusively to evaluate any given project. Appropriate components from several methodologies may have to be selected in order to satisfy a particular study. Warner and Preston have suggested the following criteria for the selection of a suitable methodology:

- (1) Use: Determination of whether the analysis will be decision or infor-

mation based is very important. Decision-based analyses must be final-action oriented in order to reveal the single best choice from a group of actions. A decision will put greater emphasis on key issues, quantification and direct comparison of alternatives. An information survey results in a broader spectrum of possible impacts.

(2) Alternatives: The difference between alternatives must be clearly defined. Alternatives may be fundamental or incremental and require different levels of analysis. Incrementally different alternatives require a greater degree of analysis than do fundamental alternatives. An example of a fundamental alternative might be the prevention of coastline erosion, whereas an incremental difference might be the prevention of erosion at a particular place along the coastline.

(3) Public Involvement: The public must be given a vital role in the analysis of the project in order to allow the public's views to have added significance. Consideration of this element in the socioeconomic assessment may be of even greater relevance.

(4) Resources: All of the available resources should be used to obtain a more quantitative analysis. Greater amounts of time, expertise, money, and data-handling (computers), however, would be required for a highly quantitative evaluation.

(5) Familiarity: Familiarity with the type of action proposed and the physical site will improve the validity of any environmental impact investigation.

(6) Issue Significance: If the issue will be very large in scope and/or controversial in character, then greater significance should be given to quantification and identification of key parameters.

(7) Administrative Constraints: Procedural and format requirements for the different agencies must be well understood in order that the range of impacts is thoroughly examined.³⁵

Warner and Preston have also suggested that impact analysis methodologies may be divided into five basic categories: ad hoc, overlays, checklists, matrices and networks:

(1) Ad Hoc: Ad hoc methodologies suggest broad areas of possible impacts rather than defining specific parameters and provide minimal guidance to impact assessment. Ad hoc methodologies are concerned with the immediate impact upon

a particular ecosystem, e.g., "What would be the impact upon the flora and fauna rather than specific parameters such as physical and chemical aspects?" Thus, the analyses is not concerned with a hierarchical system of categories.

(2) Overlays: These methodologies are characterized by a set of maps of environmental parameters (physical, social, ecological, and aesthetic) for a proposed area. The regional environment characterization is produced by overlaying these maps. Impacts are then noted which lie within the project area. Overlays may be identified by looking at the overlay in the different areas to be investigated, e.g., "How would a chemical change in the oxygen content of the water affect one or more ecological systems and thus cause some related changes?" Such a change might be an obstructed view or a change in the marine life of an area. Thus, there may be an overlapping effect as reflected in the chemical, ecological (biological), and physical changes taking place in the environment.

(3) Checklists: Checklists present a specific list of parameters to be studied for possible impacts. One-to-one applicability is not required for the proposed project, and guidelines are optional. Checklists are combinations of parameters one would like to have examined in order to determine those effects that a changing environment would experience when applied to the list. The list might include wave velocity, current, temperature, oxygen content, and suspended particles as they relate to water. Each one of these parameters would be examined for possible impacts upon the environment.

(4) Matrices: Matrices differ from checklists by presenting a list of project activities in addition to the checklist of environmental parameters. A matrix indicates cause-effect relationships between specific activities and impacts. The matrix may list specific actions which impact with environmental parameters or it may list the range of these actions. Matrices are composed of two distinctive lists. One list incorporates all project activities whereas the other includes the impacted environmental characteristics. An example of a matrix is shown in Figure 3-3 with project activities listed vertically and impacted environmental characteristics listed horizontally. This is not a complete matrix but only a simplified example showing one possible application.

(5) Networks: These methodologies are characterized by a list of cause-condition-effects which is an attempt to show that some impacts may be produced by a project action. A set of possible networks is defined which allows the user to identify impacts by selecting and tracing out appropriate project ac-

tions. Networks are used to study the cause-condition-effect. Besides affecting the present system, a project may produce a new set of environmental parameters. Thus, one must be able to counteract these changes and also minimize any changes to the present environment. There is, consequently, an interlocking of networks that must be used to identify impacts by selecting and tracing out project actions.³⁶

It should be noted that the sophistication of the analytical method may outstrip the accuracy of the data. The results of any analysis must be carefully interpreted, in the light of both data and analytical limitations.

To be effective and to comply with NEPA's requirements, an environmental impact assessment must deal with certain suggested criteria. In order to evaluate the adequacy of the assessment, it must show relationships that include impact identification, measurement, interpretation, and communication. Under each of these areas would be several subcategories that would give a complete and comprehensive survey to all impact parameters affected by or affecting the offshore complex. Other criteria that would add to the adequacy of the impact assessment are source requirements, replicability, and flexibility.

Impacted Environmental Characteristics	Project Activities		
	Deepwater Port	Airport	Nuclear Power Plant
Physical	X		
Chemical		X	X
Ecological	X	X	X
Aesthetic	X		

Figure 3-3
EXAMPLE OF MATRIX METHODOLOGY

Any of the methodologies previously described could be applicable to an offshore island complex depending upon the user and the results that one expected. Some combination of the checklist and matrix methodologies would seem to be well-suited for an offshore island complex because of the interactions between and among its different components and the variables to be assessed.

QUALITY OF LIFE

The statement of purpose of the National Environmental Policy Act (discussed in Chapter I) reads as follows:

Sec. 2. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.³⁷

From one point of view, the reason for doing impact assessment is to comply with an enlightened understanding of this act. Charles Wolf's remarks on social impact assessment (SIA) apply here.

Perhaps the most direct way of defining SIA is by analogy with the environmental impact assessment required by...the National Environmental Policy Act of 1969 (NEPA). Following the NEPA precedent, 'social impacts' are then understood as an extension or broadening of environmental impacts, and indeed, procedures for SIA do generally resemble those prescribed for environmental impact assessment. But at the most general level, the problem of SIA is a problem of estimating and appraising the condition of a society organized and changed by large-scale applications of high technology.³⁸

There is another more fundamental reason for doing socioeconomic impact assessments. Initial implementation of the NEPA focused on the natural environment and was broadened eventually to include the social environment. There is an obvious explanation for this, since the whole point of doing environmental impact assessment is to avoid or ameliorate adverse impact on the lives of individuals dependent upon the environment. The ultimate concern is with the social environment, and the more fundamental point of view goes beyond seeing social impact assessment as mere compliance with the NEPA; instead it is seen as a humane attempt to anticipate and avoid or ameliorate adverse impacts on the quality of life (QOL) of humans. In fact, one could argue that it was this

concern which motivated the original NEPA legislation. This concern still exists, with the results that there are both humane and legal reasons for doing environmental impact assessments.

While there is a growing interest in developing an overall measure of quality of life, the state of the art has progressed only to the level of generating quality of life indicator checklists (Figure 3-4). Because checklists can be useful in preliminary impact assessment, three points deserve mention.

First, various lists that might be constructed are seen inevitably being as incomplete; however, this need not be viewed as a liability. For purposes of environmental impact assessment, a satisfactory research strategy is to start with a plausible list of QOL indicators and make a concerted effort to tailor the list to the unique problem at hand.

Second, it needs to be emphasized that the concept of QOL contains an important subjective element that should be allowed for explicitly in any impact assessment. For example, what might be taken reasonably as an objective indicator of some impact category (e.g., actual "high/low" employment statistics for some group as an indication of employment opportunity) will not necessarily correlate in the expected way with the subjective evaluation of that category by the target group (e.g., that opportunities for employment are "high/low"). A satisfactory quality of life checklist will include subjective quality of life indicators.

Third, it cannot be over emphasized that different social units will be impacted differentially. This has been put very well by Shields:

The point is that the impacts of high technology projects affect different people in different ways at different times. Some people lose a great deal, others gain, and others most probably fall somewhere in between, gaining in some ways but losing in others. And there are certainly some--indeed, many--who are virtually unaffected by project impacts. So it is quite clear that differential impacts are what social impact assessment is all about.³⁹

One must attend very carefully at several levels to the question of who is impacted and how, with the expectation that there will be differential impacts.

There has been a clear shift in attitude toward social policy in recent years, from a naive utilitarianism striving to maximize national happiness as measured by the GNP to an emphasis on social justice or equality (equity) of treatment for individuals and various groups. That any large-scale project is

INSTRUCTIONS: Consider how the highway alternative affects various categories of people (population segments) on each of the following quality of life indicators and indicate your judgment of the degree of impact, both favorable or unfavorable, according to the following scale of impacts, blank = insignificant, ± 1 = moderate, ± 2 = significant (worth noting but not extreme), ± 3 = extreme (definitely require attention). It is suggested that you fill out this sheet in the following three steps: (1) Check the quality of life indicators that might be affected by the highway, (2) Check the population segments which might be specially affected by the highway, and (3) Consider the cells which cross the checked columns and rows and leave blank or indicate moderate, significant or extreme impacts.

**STEP 1: CHECK QOL INDICATORS
AFFECTED BY THE HIGHWAY**

**STEP 2: CHECK SPECIALLY
AFFECTED POPULATION SEGMENTS**

**STEP 3: SCORE THE CROSSCUT
CELLS**

QUALITY OF LIFE INDICATORS

ECONOMIC
Standard of Living
Unemployment & Fincl Dependency
Availability of Goods & Serv
Housing & Habitat
Transportation Convenience
SOCIAL
Family Relations
Friendships
Job Satisfaction
Crime & Violence
Health, Safety
Education
PSYCHOLOGICAL
Love, Companionship
Freedom of Movement
Peace of Mind
Challenge, Variety
Other
LEISURE
Media & Other Entertainment
Cultural Opportunities
Recreation Facilities
Areas of Natural Beauty
Exposure to Pollution
Exposure to Noise
POLITICAL
Political Participation
Freedoms & Civil Rights
Government Responsiveness
Equality & Justice
OTHER QUALITY OF LIFE IMPACTS
Etc.

POPULATION SEGMENTS

FIGURE 3-4

EVALUATION SHEET FOR THE HIGHWAY IMPACT ON THE QUALITY OF LIFE (QOL)
OF VARIOUS POPULATION SEGMENTS

Source: Finsterbusch, K., "A Policy Analysis Methodology for Social Impacts," Journal of the International Society for Technology Assessment, March 1975, pp. 5-15.

expected to survive, or even thrive in the market and augment the GNP is no longer a sufficient justification for its implementation. There is an increasing concern with the distribution of the benefits and, especially, the costs of such undertakings. An understanding is evolving of what "just" or "equitable" distribution means. Seen in this light, the intent of environmental legislation is to assure an equitable allocation of benefits and costs of projects which impact on the environment.

One is enjoined from any technological and/or industrial development which does not try through an impact assessment to anticipate the effects of such a development on all aspects of the environment of human interest. Furthermore, if such an assessment is to have any utility, developmental activity which adversely impacts the quality of lives of others will have to be prohibited unless satisfactory measures are taken for the compensation of those adversely impacted.

END NOTES

- ¹ Adapted from The Environmental Assessment Notebook Series, Notebook 2: Social Impacts, prepared for the U.S. Department of Transportation, National Technical Information Service, Springfield, Va., 1975, p 7.
- ² The Environmental Assessment Notebook Series, Notebook 3: Economic Impacts, prepared for the U.S. Department of Transportation, National Technical Information Service, Springfield, Va., 1975.
- ³ Ibid.
- ⁴ Gold, R.L., "Social Impacts of Strip Mining and Other Industrializations of Coal Resources," in C.P. Wolf (ed) Social Impact Assessment. Milwaukee: Environmental Design Research Association, 1974, pp. 123-146.
- ⁵ The Environmental Assessment Notebook Series, Notebook 3 . . . , op cit, pp. 51-53.
- ⁶ Ibid., pp. 61-65.
- ⁷ Ibid., p. 75.
- ⁸ Ibid., pp. 47-48.
- ⁹ Shields, M.A., "Social Impact Studies: An Expository Analysis," Environment and Behavior, September 1975, 7, p. 267.
- ¹⁰ Ibid.
- ¹¹ The Environmental Assessment Notebook Series, Notebook 2 . . . , op. cit., p.98.
- ¹² Ibid., pp. 93-94.
- ¹³ Ibid., pp. 101-103.
- ¹⁴ Ibid., pp. 111-112.

- 15 Ibid., pp. 112-113.
- 16 Greenberg, M.R., Krueckeberg, D.A., and Mautner, R., Long-Range Population Projections for Minor Civil Divisions: Computer Programs and User's Manual, (New Brunswick, New Jersey: Center for Urban Policy Research, Rutgers University, May 1973).
- 17 Ibid., p. 37.
- 18 Commonwealth of Virginia, Council on the Environment, Virginia and the Outer Continental Shelf: Problems, Possibilities and Posture, (Richmond, Virginia, Nov. 7, 1974), pp. 66-67.
- 19 New York Offshore Airport Feasibility Study, Report No. FAA-RD-74-184, V.I., Dec., 1974, pp. II-57-58.
- 20 Potential Onshore Effects of Deepwater Oil Terminal-Related Industrial Development, Vol. IV, Part Five: Appendices, Arthur D. Little, Inc., National Technical Information Service, U.S. Department of Commerce, Springfield, Va., 1973.
- 21 The Environmental Assessment Notebook Series Notebook 3. . . , op. cit.
- 22 Potential Onshore Effects of. . . , op. cit., p. 127.
- 23 Ibid., p. 31.
- 24 The Environmental Assessment Notebook Series, Notebook 3. . . , op. cit., pp. 54-60, 85-86.
- 25 Perloff, Harvey S., and Wingo, Lowdon, Jr., Eds., Issues in Urban Economics, Baltimore, Md.: The John Hopkins Press, 1968, pp. 166-167.
- 26 Potential Onshore Effects of. . . , op. cit., p. 129.
- 27 Ibid., p.
- 28 The Environmental Assessment Notebook Series, Notebook 3. . . , op. cit., pp. 122-123.
- 29 Helly, Walter, Urban Systems Models, New York: Academic Press, 1975, p. 57.
- 30 Ibid., pp. 59-74.
- 31 The Environmental Assessment Notebook Series, Notebook 3. . . , op. cit.
- 32 Isard, W. and Coughlin, R.E. Municipal Costs and Revenues Resulting From Community Growth. Boston: Federal Reserve Bank of Boston, 1972, cited in The Environmental Assessment Notebook Series, op. cit., p. 151.
- 33 The Environmental Assessment Notebook Series, Notebook 3. . . , op. cit., pp. 150-153.
- 34 Ibid., p. 162-177.
- 35 Warner, M.L., and Preston, E.H., 1974, A Review of Environmental Impact Assessment Methodologies. Columbus, Ohio, Battelle Columbus Laboratories Environ. Prot. Agency Report EPA-600/5-74-002, 27 p., pp. 1-3.
- 36 Ibid., pp. 3-4.
- 37 The National Environmental Policy Act. 42 U.S.C. 4341, et seq. (1975).

- 38 Wolf, C.P. (1974) "Social Impact Assessment: The State of the Art," in C.P. Wolf (ed.) Social Impact Assessment. Milwaukee: Environmental Design Research Association, p.2.
- 39 Shields, Mark A., "Social Impact Studies: An Expository Analysis," pp. 265-284 in Environment and Behavior, Volume 7, Number 3, September 1975.

CHAPTER IV

LEGAL AND INSTITUTIONAL CONSIDERATIONS

Chapter IV

LEGAL AND INSTITUTIONAL CONSIDERATIONS

INTRODUCTION

Among the first steps in considering a major offshore undertaking would be a review or evaluation of the legal, political, and institutional contexts. This step has become more pronounced with the advent of the present consciousness and awareness over environmental, energy, social, economic, and other impacts. The bulk of such considerations belongs at the federal level with the states exercising substantial influence over projects affecting regional and national policies.

The states compete among themselves in the United States Federal System. In the past few years, the competition has taken the form of a debate over priorities between economic growth, the value of technology, energy self-sufficiency, environment, and quality of life. Reaching a national consensus has been made more difficult by uneven geographical trade-offs between competing values derived from economic growth.

Within this context the concept and potential of an offshore complex assumes special interest. Trade-offs between economic growth on the one hand, and fears at the local level over the environment, safety, and property values on the other, present a difficult situation for the government decision-making process.

Consideration at the early stages of a project would concentrate on existing laws and their adequacy, agency involvement and attitudes, licensing procedures, and financing alternatives. The present chapter addresses questions relating to legal and institutional relevance, federal agencies taking part in the decision-making process, as well as factors relating to liability and ownership.

LEGAL CONSIDERATIONS

Applicable Laws

Wherever an island complex is built, international and federal laws will apply along with state and local laws if it is located within a state's juris-

diction. Federal laws are probably the most important to consider; at least they are the most numerous. Some laws center on a specific use such as deep-water ports, while others apply to a variety of activities with which a complex could be concerned: conservation, environmental protection, navigation, research, and transportation. These laws extend various distances from shore and cross jurisdictional lines. Some have been enacted for decades such as the Rivers and Harbors Act of 1899,¹ but most are of recent vintage, providing extensive authority to the agencies responsible for regulating the oceans. New laws are being enacted with such speed that any comprehensive listing of those applicable will be out of date within a few years. Generally, however, laws applying to offshore artificial complexes can be found (1976) in the following titles of the United States Code:

- Title 14 - Coast Guard
- Title 15 - Commerce and Trade
- Title 16 - Conservation
- Title 18 - Crimes and Criminal Procedure
- Title 19 - Customs Duties
- Title 29 - Labor
- Title 33 - Navigation and Navigable Waters
- Title 42 - The Public Health and Welfare
- Title 43 - Public Lands
- Title 46 - Shipping
- Title 49 - Transportation
- Title 50 - War and National Defense

Depending upon location, state and local laws may also have to be considered. Applying state law is often difficult because of the potential conflicts with federal law and the laws of the other 49 states. States often have jurisdictional disputes with each other and frequently courts in several states will decide the same issue, sometimes with conflicting results. Problems then arise in the other states as to which law to recognize. The federal government has pre-empted the states in many areas of the law. In some areas, e.g., national defense and interstate commerce, the distinction is clear; in others, such as the development of offshore complexes, the distinction is not clearly drawn.

Because an offshore artificial complex is a relatively new idea, there are many specific legal questions involving jurisdiction and state laws:

- (1) If a crime is committed on the complex, who will have jurisdiction?
- (2) Where will the trial be held?
- (3) What law will be applied in civil cases?
- (4) Where will injury and death claims be brought?
- (5) Does it make a difference whether the claims are employment related or not?
- (6) What workmen's compensation laws are in effect?
- (7) Workmen's Compensation generally applies only to work related injuries. Suppose as a condition of employment, an employee is required to live on the complex for extended periods of time. If he has an accident while on the complex but not at work, does workmen's compensation cover the injury?

An examination of existing laws provides only some of the answers to the above questions. With regard to criminal jurisdiction, if a complex is constructed for purposes of exploration and exploitation of the resources of the continental shelf, the Outer Continental Shelf Lands Act of 1953² would apply the adjacent state's laws insofar as no conflict arises with federal law. The Deepwater Port Act³ provides for similar treatment for deepwater ports beyond the territorial waters of the United States. But what if the main function of the island is an airport? or a pipeline terminal? Other than for the specific functions mentioned above, the law does not address the question of criminal jurisdiction of offshore facilities located more than three miles beyond shore.

The problems of civil jurisdiction are identical to those of criminal jurisdiction. Present laws cover offshore facilities built only for very specific purposes. These omissions can be remedied either by amendments to existing legislation or by new legislation.

Laws covering the other problems mentioned above contain similar deficiencies. Usually workmen's compensation laws apply not only to the place of injury but also to the place at which a contract for work is made. Therefore, sometimes workmen's compensation laws will apply to workers on offshore facilities not located in state waters and sometimes they will not. Clarification is needed before the first workman is injured, otherwise the inevitable will occur--states will disclaim responsibility and place liability elsewhere.

Once the functions of an offshore complex are identified, further analysis of the relevant federal, state, and local law is needed. Laws relating to functions must be considered separately and collectively. The integration of primary, secondary, and tertiary offshore complex functions creates many potential conflicts, and overlaps within the law. Finally, the geographical site of

the complex is also important in considering state and local law.

A transportation complex can have many uses and modes, among which are landing facilities, port facilities, an air-land-sea interface system, pipeline terminal, utility tunnel, transport service facility, outer space launching pad, rescue operation base, hovercraft facility, helicopter landing pad and any combination thereof. If a complex contains port facilities for petroleum handling, then the Deepwater Port Act of 1974⁴, whose purpose is to authorize and regulate the location, ownership, construction, and operation of deepwater ports in waters beyond the territorial limits of the United States,⁵ is relevant. Since this act only concerns ports beyond the territorial limits of the United States, state and local laws will have to be considered if the offshore complex contains a port and is located close to shore.

If the offshore complex is to contain landing facilities, then it will have to comply with all laws administered by the Federal Aviation Administration (FAA) which is charged with the responsibility of developing an airport system for the United States. It also determines eligibility for funding by the (Airport and Airways) Trust Fund created under the Airport and Airway Revenue Act of 1970.⁶ The FAA may not be the only regulatory authority. Many airports are still under local control even though this situation is changing as federal assistance to local airports increases. Some states license airports not controlled by the federal government; other states avoid conflict with federal regulations by licensing them only for commercial or tax purposes.

A transportation/energy complex may result in numerous legal and regulatory conflicts. For example, assume that the offshore complex contains facilities for air transportation and nuclear energy. Under the Federal Aviation Act of 1958⁷ and the Department of Transportation Act of 1966,⁸ the FAA is required to review and endorse plans relative to potential obstructions affecting navigable air space. Not only would the presence of a nuclear plant limit the freedom of aircraft traffic in its vicinity, but it also raises the risk of serious accidents.

Future Laws

An accurate forecast of future laws is presently not possible because too many questions, such as where will the complex be built, when will it be built and what functions will be performed, remain to be answered. Instead, a

summary of how and when future laws should be enacted and a discussion of the necessity or desirability of a federal act specifically for offshore island complexes.

Generally laws are enacted in response to problems. If problems can be identified early, solutions (new laws or amendments to existing ones) can be implemented, thereby resolving the problems before they become unmanageable. To make an early problem identification, the probable impacts of the offshore complex should be studied. The legal decision-maker should consider these probable impacts, make a legal assessment as to whether or not current laws are adequate, and enact new laws as they are appropriate.

At such time as a large-scale offshore complex becomes a reality, the question of the necessity or desirability of a federal act specifically directed at offshore artificial island complexes must be considered, especially if existing federal legislation does not provide adequately for the initiation, development, financing, and operation of an offshore complex. Among the advantages of such an act would be to: (1) insure that decisions are made carefully, and expeditiously; (2) avoid overlap and omissions of all relevant laws; (3) allow for ease of amendment, regulation, and control; (4) avoid inter-governmental conflict by assigning authority to one department; (5) provide a mechanism for resolving jurisdictional disputes; and, (6) shorten delays or avoid terminations by legal processes.

Regulation of the Complex

Laws provide the necessary framework for the operation of an offshore complex, but generally they are not flexible enough for its administration. Consequently, regulations are passed to supplement laws.

Regulations generally provide the machinery for issuance of various permits, licenses, certifications, and approvals needed in any major project. Since an offshore, complex is a major project, a great many agencies would be required to approve and issue an even greater number of permits.

Proponents of having one agency coordinate this operation argue that the application procedure is simplified, substantial overlap is eliminated, and one agency gets a birds-eye-view of the whole procedure. They point to the gaps and overlaps in existing regulations with regard to such crucial items of Outer Continental Shelf (OCS) technology such as pipelines and platforms

which are the major sources of oil spills resulting from offshore activities in the Gulf of Mexico.⁹

On the other hand, opponents of centralization claim there is no elimination of red tape, that centralization leads to a narrow perception of the problem, and that one agency cannot possibly have the required expertise to analyze the problem thoroughly.

A recent study by the Office of Technology Assessment¹⁰ has recommended consolidating within one office of the Department of Interior full-time responsibility for all phases of the OCS program to create more coherent policies for OCS development and regulation. Presently, responsibility is divided among several Interior bureaus and offices.¹¹ This study indicates that a need has been demonstrated "for improved coordination of OCS-related activities both within Interior and among Interior, other Federal agencies, and the States."¹² For example, state laws which merely duplicate the efforts of federal laws are of no use and should be eliminated to keep bureaucratic headaches at a minimum. A decision to centralize will allow one agency to manage the whole application procedure so that an applicant has only one stop to make.

If one agency does not have authority to coordinate the permit procedure, then laws or regulations are needed to resolve the inevitable interagency conflicts. Even the most outspoken opponents of centralization recognize that conflicts are inevitable and machinery must be set up to handle these disputes. To a certain extent this requires centralization. The required machinery can be in the form of veto authority by a single agency or a voting process whereby all interested agencies in a project cast their vote in favor of one of the agencies involved in the dispute. The point is that these problems should be anticipated and resolved before the conflicts arise.

Whether one or several regulatory agencies coordinate the procedure, a predevelopment assessment should be made to determine the extent to which development, construction, and administration of an offshore complex will result in additional regulatory burdens on governmental agencies. In making this assessment the following factors should be considered:

- (1) which agency(ies) or department(s) will have the primary regulatory burden;
- (2) how many complexes will be built;
- (3) how large will they be; and,
- (4) what function will be performed at each complex.

Before an offshore complex is built, there should be sufficient assurances that all regulatory agencies have adequate staffs for proper development and administration of the complex.

SPECIFIC LEGAL PROBLEMS OF OFFSHORE COMPLEXES

Compensating Impacted Areas

An offshore artificial island complex will have some impact on the adjacent coastal area. If it is determined that an offshore complex will adversely affect the onshore community, then the issue of compensation arises. The Deepwater Port Act allows an "adjacent coastal state" and any other state in which land-based facilities directly related to a deepwater port facility are located to set reasonable fees for the use of such land-based facilities. Fees may be fixed for any economic cost attributable to the construction and operation of such deepwater port and related land-based facilities.¹³ Of course, this only answers part of the problem. It does not provide adequate compensation for social, financial, institutional, and recreational costs and expenses incurred by the coastal community.

A recent study by the Office of Technology Assessment recognized this problem.¹⁴ The study analyzed the coastal effects and their consequences for the states of New Jersey and Delaware of three proposed offshore energy systems: development of oil and natural gas, construction of one or more deepwater ports, and construction of a floating nuclear power plant. The study concluded that while most states would receive fiscal benefits, there might be detrimental fiscal impacts for some localities and for entire states under certain circumstances.¹⁵

A number of options were proposed to alleviate this problem, including:

- (1) a provision for planning grants and technical assistance to states that would be effected by anticipated OCS (Outer Continental Shelf) development.
- (2) a provision for "front money" loans or bond guarantees to state and local governments to help finance public services that must be provided before revenues are received to pay for them.
- (3) a provision to share a fixed percentage of federal OCS revenues, with the affected states.
- (4) a provision for grants to be distributed according to a formula including factors related to the expected levels of onshore impacts.
- (5) a provision for grants based on a demonstration of expected net negative impacts.¹⁶

As this report was written, President Ford signed into law the Coastal Energy Impact Bill, which "authorized federal financial assistance to build roads, schools, hospitals, sewage systems and water purification facilities for communities on the coasts of the oceans and Great Lakes whose populations might expand because of energy projects."¹⁷

Since an energy-related artificial island complex might expand the onshore population, this bill may be an effective tool for compensating states and municipalities. As Mr. Ford noted, "it is an encouraging sign for the future,"¹⁸ and it does show that the need for energy can be reconciled with the needs for social, economic, and environmental protection.

Taxation

Certainly all governmental entities, from the smallest municipality to the Federal Government, will be interested in taxing the operations, property, and personnel of the offshore complex. The Federal tax system consists of income taxes (both personal and corporate), import duties, social security taxes, royalties, and excise taxes. In all probability the Federal Government will be able to rely on all of these to tax an offshore island complex.

Problems develop with regard to taxation by state and municipal governments. The Outer Continental Shelf Lands Act¹⁹ stipulates that "state taxation laws shall not apply to the outer continental shelf." This view was reinforced by the House Bill for deepwater ports which provided that "state taxation laws shall not apply to any high seas oil port or components thereof located outside the tax jurisdiction of the state." It would seem then that the states' taxing power only extends three miles from the coast; however, in conference with the Senate, the sentence from the House Bill quoted immediately above was dropped in favor of current section 19(b),²⁰ which states that "except as preempted by Federal laws and regulations, the laws of the nearest adjacent coastal state shall apply as Federal law to any deepwater port." This Act also allows an adjacent coastal state to "fix reasonable fees for the use of a deepwater facility."²¹ Whether a tax can be considered a fee is an unanswered question, but it does point out the deficiency in the tax laws as they relate to offshore structures.

An interesting question is whether a state can impose a duty on oil transported by pipelines from deepwater ports. There is a potential conflict with

federal law, specifically, whether the duty directly or materially burdens foreign or interstate commerce, conflicts with federal law, or violates the import-export clause of the United States Constitution.²² At least one court has upheld the ability of a state to impose a duty on imported oil. In Portland Pipeline Corp. v. Environmental Improvement Commission,²³ the Maine Supreme Court upheld a one-half cent per barrel fee on petroleum products transferred over water, imposed pursuant to Maine's Coastal Conveyance of Petroleum Act.²⁴ The duty was imposed on oil terminal facilities and the purpose was to create a Coastal Protection Fund to reimburse the state for cleaning costs and to compensate third parties injured by oil spills. It appears that if fees are for regulatory purposes and not general revenue measures then state duties are permissible.

Questions remain concerning the power of municipalities to tax the operations, property, or personnel of the island. A municipality's power to tax can never extend further than its state's taxing power. Unlike states, municipalities do not have inherent taxing powers. Their authorization to tax extends from statutory or constitutional grants from the state. This potential problem area cannot be settled at the federal level. The Federal Government cannot interfere with state and local tax laws unless they are in direct conflict with federal laws. These questions then will have to be resolved at the state level.

Antitrust Problems

Antitrust laws are designed to protect trade and commerce from unlawful restraints and monopolies or unfair business practices. The question, then, is whether an offshore complex concept would affect competition adversely, restrain trade, promote monopolization, or otherwise create a situation in contravention of the antitrust laws. Since it is likely that only a limited number of offshore complexes will be built in the foreseeable future, control by any one private legal entity (i.e., corporation) may have a monopolistic effect on competition.

The Deepwater Port Act addresses this problem. This act requires the Attorney General and the Federal Trade Commission to prepare a report assessing the competitive effects which may result from issuance of a proposed license for the ownership, construction, or operation of a deepwater port.²⁵ It is

anticipated that future laws concerning the establishment of offshore transportation or energy complexes will contain like provisions; however, the issuance of a license under the Deepwater Port Act is not admissible in any way as a defense to an action for violation of the antitrust laws of the United States. The problem should be addressed in detail in order to stimulate private investment.

State Controls

Under the Outer Continental Shelf Lands Act²⁶ and the Convention on the Continental Shelf,²⁷ the Federal Government has jurisdiction over all resources on the seabed beyond the territorial sea out to a depth of 200 metres, or to the limits of natural exploitation. All prospective drilling sites off the east coast fall within the exclusive jurisdiction of the Federal Government. But because a certain amount of onshore industrial development is needed to support large scale drilling operations, states and municipalities can thwart such efforts by prohibiting the construction of onshore support facilities through restricted zoning, strict emission and effluent standards, and direct statutory prohibition.

If state and local laws conflict with a perceived national interest "the Federal government has one instrument to eliminate the veto power of a state . . . If (it) . . . decided that (the oil was) essential to serve national public interest objectives, it could call upon its power under the commerce clause of the Constitution to override any state objections. Although it has such ultimate authority, the Federal government would clearly choose to exercise it only as a very last resort, if at all."²⁸

These divergent federal-state interests can often be reconciled through the Coastal Zone Management Act²⁹ (CZMA). The CZMA encourages, but does not require, coastal states to develop management programs which specify the boundaries of the coastal zone, identify the permissible land and water uses within the zone, avoid uses having adverse impacts, and specify methods for exerting such controls.³⁰ Federal funding is available to develop and administer such programs.³¹

Whether or not the CZMA will give states adequate control over offshore development remains to be seen. At least one thing is clear: coastal states will have some voice in shaping the development of offshore facilities.

Jurisdictional Problems

Jurisdictional issues raised by offshore facilities can be summarized as follows:

- (1) Who can build what?
- (2) Where can it be built?
- (3) What laws will govern?

The first two are questions of jurisdiction to construct; the third is a question of jurisdiction to control.

Perhaps the most important issue to address is not jurisdiction as it exists today but as it will probably prevail 25 years from now. Assuming relative political stability, jurisdictional boundaries probably will be extended in the near future, though to what extent remains an open question.

A determination of territorial boundaries only resolves some of the problems and even if definite boundaries are established, other questions remain unanswered. For example, suppose territorial boundaries remain at three miles, may the United States, either alone or in conjunction with another country or organization, establish an offshore complex four miles off its mid-Atlantic Coast? If boundaries are established at 12 or 200 miles, the same question is whether a foreign country or organization may establish an offshore complex off the Mid-Atlantic Coast of the United States, a mile or two beyond the established territorial boundary, whatever that might be. Many landlocked countries of the world may have potential interest in such development.

Of course these questions would be academic if the United States chooses to exert authority over the high seas (which may be necessary to prevent other countries from developing an offshore complex) or extends full protection to United States offshore complexes constructed beyond territorial boundaries.

The obstacles and barriers to developing offshore artificial complexes are formidable. Present international law does not answer the questions of who, what, and where. These questions can be answered with certainty only with respect to the development of an offshore complex within the internal or territorial waters. In order to promote establishment of offshore complexes, these barriers will have to be overcome.

ENVIRONMENTAL LEGAL CONSTRAINTS

As noted in Chapter I, the environmental legal constraints involved in the building of an offshore complex are numerous, evolving from the National Environmental Policy Act of 1969; the Federal Water Pollution Control Act; the Marine Protection, Research, and Sanctuaries Act of 1972; Clean Air Acts and Amendments, the Outer Continental Shelf Act; and, the Coastal Zone and Management Act. Secondary statutes contribute to this network of acts to make a comprehensive legal requirement which must be considered. The entire conglomeration of acts serve to accomplish the government's long run goal of ". . . promoting efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man . . ."³²

Water Regulations

Of the many laws which govern the use of the nation's waterways, the Federal Water Pollution Control Act (FWPCA) and its amendments, and the Marine Protection, Research, and Sanctuaries Act of 1972 (ODA) constitute major legal criteria in the establishment of an offshore artificial island complex. Since the construction and eventual use of the complex will undoubtedly involve discharge material, the operators of the complex must adhere to the regulations which evolve from the FWPCA and ODA. These regulations govern significant numbers of activities that will affect the construction and function of the island. Additionally, these regulations prescribe standards for the permits which authorize and sanction certain water-related activities.

One of the primary water regulations which applies to the construction of an offshore complex is the Army Corps of Engineers Regulations on Navigable Waters (RNW).³³ This body of law prescribes the policy, practice, and procedure to be followed by all Corps of Engineers installations and activities in screening applications for permits authorizing structures and works which will affect the navigable waters of the United States. Also, RNW provides the standards which specifically govern permits that provide for any dredge or fill operations.³⁴ Under the RNW, the corps considers the following factors when reviewing a permit application:

- (1) the extent of the public and private need for the proposed structure or work;
- (2) the desirability of using appropriate alternative locations and methods to accomplish the objective of the proposed structure;
- (3) the extent and permanence of the beneficial and/or detrimental effects that the proposed structure may have on the public and private uses to which the area is suited; and,
- (4) the probable impact of each proposal in relation to the cumulative effect created by other existing and anticipated structures or work in the general area.³⁵

Additionally, the Corps evaluates the proposal in view of the needs and welfare of those affected. Such factors as state water quality programs; potential interference with adjacent properties or water resource projects; impacts on wetlands; and the historical, scenic, and recreational values of the site, are considered in the Corps's final decision.³⁶

In order to determine the project's effect on the public welfare, the regulation requires that public notice be given of the proposed action. Such notice also gives interested parties the opportunity to evaluate the potential effects, and submit written comments. The notice must include a:

- (1) brief description of the proposed activity, its purpose and intended use. . .;
- (2) plan and elevation drawing showing the general and specific site location and character of all proposed activities. . .;
- (3) list of other government authorizations obtained or requested. . .;
- (4) statement concerning a preliminary determination of the need for and/or availability of an environmental impact statement; and,
- (5) reasonable period of time, normally thirty days from date of mailing, within which interested parties may express their views concerning the permit application.³⁷

In assessing the public's potential sentiment, the Corps relies heavily on the written responses of interested parties.

In the final analysis, the Corps must evaluate all the information received in order to compile a final report on the applicant's project. The criteria in the Corps' report provide the island proponents with a number of considerations which should be included in the project plans:

- (1) views of state and local authorities;
- (2) views of the District Engineer concerning the probable effect of the proposed work on:
 - a. navigation,
 - b. harbor lines,
 - c. floods heights, drift, and flood damage protection
 - d. beach erosion or accretion,

- e. conservation,
- f. fish and wildlife,
- g. water quality,
- h. esthetics,
- i. ecology,
- j. historical values,
- k. recreation,
- l. economy,
- m. water supply, and
- n. coastal zone management plans;

(3) views of the public; and,

(4) a copy of the environmental assessment and summary of the EIS.³⁸

All decisions may be reviewed by the administrator of the EPA and also by the Council on Environmental Quality.

A second regulation which governs the use and construction of an offshore complex is the Environmental Protection Agency Criteria for Evaluation of Permit Applications for Ocean Dumping (PAOD).³⁹ Under the authority of the Marine Protection, Research, and Sanctuaries Act (MPSA) and the FWPCA, the administrator of the EPA designates specific standards for the dumping of material into the "ocean waters."⁴⁰ The EPA classifies various materials according to their impact on the environment. The operators of the complex cannot dump the following materials:

- (1) highly radioactive wastes;
- (2) materials produced for radiological, chemical, or biological warfare;
- (3) materials insufficiently described in terms of their physical, chemical, or biological properties to permit evaluation of their impact on marine ecosystems; and,
- (4) persistent inert synthetic unnatural materials which may float or remain in suspension in the ocean.⁴¹

Additionally any materials containing the following contaminants cannot be dumped:⁴² (1) organohalogen compounds; (2) mercury and mercury compounds; (3) cadmium and cadmium compounds; and, (4) crude oil, fuel oil, heavy diesel oil, and lubricating oils. Moreover, the regulation defines certain substances which require "special care" and other highly reactive substances which may be permitted under EPA directions and specifications.⁴³

If dredge and fill operations are employed in the construction of the complex, such activities must comply with the provisions of the PAOD. The dredge material used in this operations should be "unpolluted," which the

regulation defines as material "composed essentially of sand and/or gravel, or of any other naturally occurring sedimentary materials. . . ."⁴⁴ Such unpolluted dredge material may be dumped at any site which has been approved for the dumping of solid wastes of natural origin. Specific East Coast sites approved for dumping of unpolluted dredge material are shown in Table IV-I.⁴⁵

In coordination with RNW and PAOD, the EPA also has specific rules governing dredge and fill materials in its Interim Regulations on Discharge of Dredged or Fill Material into Navigable Waters (RDFM).⁴⁶ RDFM establishes criteria for the siting of dredge or fill operations. The District Engineer must evaluate each dredge and fill proposal in terms of:

- (1) physical effects;
- (2) chemical-biological interactive effects;
- (3) water column effects; and,
- (4) effect of dumping on benthos (organisms that live on or near the bottom of the ocean).⁴⁷

Additionally, the District Engineer reviews each project to assure that the proponents:

- (1) avoid activities that significantly disrupt any food chains;
- (2) recognize that discharge activities might destroy or isolate areas that serve the function of retaining natural high waters;
- (3) avoid discharge activities that inhibit the movement of fauna, especially their movement into and out of feeding, spawning, breeding, and nursery areas;
- (4) minimize discharge activities that will degrade esthetic, recreational, and economic values;
- (5) avoid discharge activities that will destroy wetland areas having significant functions in maintenance of water quality.⁴⁸

Under the RDFM, the proponents of the complex must demonstrate that there is a need for the facility. Moreover, alternate sites must be chosen; however, the proponents may consult the District Engineer and the Regional Administrator for advanced identification of dredge material disposal areas.⁴⁹

Congress has established several other regulations under the authority of the FWPRA. If the proposed complex contains an oil extraction or refining operation, the proponents must be cognizant of the Council on Environmental Quality's National Oil and Hazardous Substance Pollution Contingency Plan (PCP).⁵⁰ Under PCP, Congress seeks "to provide for efficient, coordinated, and effective

TABLE IV-I
APPROVED EAST COAST DUMPING SITES
FOR DREDGE OR FILL MATERIAL

<u>LOCATION</u> (Latitude and Longitude)	<u>SIZE</u> (Sq. Mi.)	<u>DEPTH</u> (Feet)
Off Penobscot Bay, Maine (44° 14', 68° 53')	2.0	120
Off Platts Bank, New Hampshire (43° 33', 69° 55')	2.0	100
25 mi. Southwest of Boston, Massachusetts (42° 22', 70° 40')	2.0	174
10 Mi. East of Narragansett, Rhode Island (41° 24', 71° 18')	2.0	108
Sandy Hook Sound, New Jersey (40° 24', 73° 51')	2.0	88
25 mi. East of Chincoteague Bay, Maryland (18° 11', 67° 12')	2.0	(unknown)
2½ mi. East of Dam Neck, Virginia (near 26° 46', 75° 55')	3.0	38
16 mi. Northeast of Cape Henry, Virginia (near 37° 05', 75° 42')	4.0	63

action to minimize damage from oil and hazardous substances, including containment and removal.⁵¹ The plan provides a series of requirements which help to abate any condition or danger caused by the discharge of oil or dangerous substances.⁵²

The Environmental Protection Agency Regulations on Oil Pollution Prevention (OPP) is very similar to the CEQ's pollution contingency plan.⁵³ OPP includes:

- (1) requirements for preparation and implementation of Spill Prevention Control and Countermeasure Plans;
- (2) specific requirements for onshore and offshore facilities (maintenance, crew on hand, etc.);
- (3) guidelines for the preparation and implementation of a Spill Prevention Control and Countermeasure Plan; and,
- (4) civil penalties for violation of Oil Pollution Prevention Regulations.⁵⁴

Lastly, the island complex proponents must comply with the effluent requirements for the various activities or anticipated uses. If a complex contains an oil extraction operation, the proponents must comply with the EPA's Effluent Guidelines and Standards for Offshore Oil and Gas Extraction (EGOG).⁵⁵

This regulation contains effluent limitations for the following pollutants:

(1) produced water, (2) deck drainage, (3) drilling muds, (4) drilling cuttings, (5) well treatment, (6) domestic wastes, and (7) produced sand. Under the EGOG, there are specific effluent standards for near-offshore and far-offshore facilites.⁵⁶

The EPA also has Effluent Guidelines and Standards for Petroleum Refining (EGPR).⁵⁷ If such an operation is employed on an artificial island, the proponents must comply with limitations on the following substances: (1) biological oxygen demand, (2) total suspended solids, (3) chemical oxygen demand, (4) oil and grease, (5) phenolic compounds, (6) sulfide, (8) chromium (also, Hexavalent chromium), and (9) pH levels.⁵⁸ Moreover, the EGPR has specific pretreatment standards and effluent limitations for "new sources," such as an offshore complex.⁵⁹ In general, the regulation will govern any activity or use that takes place on the facility.

In summary, the various acts which govern activities and operations in the waters of the United States are major considerations in the construction of an offshore artificial island complex. Moreover, these acts, along with their companion regulations, involve the workings of many federal agencies which

govern any activity on the proposed complex.

Air Regulations

Any efforts made to construct or use the offshore complex undoubtedly will require the discharge of substances into the air. Therefore, the proponents of the facility must be cognizant of the Clean Air Act and Amendments of 1970 (CAA), which governs the emission of pollutants into the atmosphere.

A primary air regulation with which the proponents must comply is the Environmental Protection Agency Regulations on National Primary and Secondary Ambient Air Quality Standards (PSAQAs).⁶⁰ Under the authority of the CAA, the EPA has established National primary and secondary ambient air quality standards for the following substances: (1) sulfur oxides (sulfur dioxides), (2) particulate matter, (3) carbon monoxide, (4) photochemical oxidants, (5) hydrocarbons, and (6) nitrogen dioxide.⁶¹ The administrator of the EPA defines the level of air quality and lists these standards in units of micrograms per cubic metre. These levels are revised yearly, and promulgated to protect the public health.⁶²

The Environmental Protection Agency Regulations on Standards of Performance for New Stationary Sources (SPNS)⁶³ constitutes the second CAA regulation which is applicable to the proposed complex. This law requires that the owner or operator of any stationary source plan and construct the facility in accordance with EPA standards and requirements. For most facilities governed by the SPNS, the EPA requires:

- (1) detailed plans for the new facility, to include structural design and maintenance;
- (2) adequate record keeping of construction progress and data;
- (3) equipment performance tests;
- (4) adequate monitoring devices on polluting equipment;
- (5) consultation with local and state air quality administration; and,
- (6) periodic emission inventories and source surveillance.⁶⁴

Aside from the general requirements for new pollution sources, the SPNS includes specific emission standards for petroleum refineries,⁶⁵ storage vessels for petroleum liquids,⁶⁶ and various other industrial uses.

In summary, the many acts (Discussed in Chapter I) and resulting regulations create complex network of constraints which the facility's proponents

must consider. Although the governing laws are numerous, the proponents should coordinate the planning and construction of the facility with the EPA, which would aid in administering and filling these acts and regulations. Moreover, if the nation's needs for improved transportation systems and energy remains acute, then it is reasonable to conclude that the proposed offshore complex will be received favorably by the various agencies and will survive the legal maze that presently governs its establishment.

Potential Litigation.

Undoubtedly, the construction and operation of an artificial island complex will have a variety of ramifications on surrounding establishments. Some of these ramifications will consist of law suits, resulting from some type of damage caused by the complex. It behooves the proponents of the complex to realize the potentiality of law suits from both private individuals and public groups.

One form of litigation which may occur consists of private damage suits. These suits involve damages to an individual's person or property.³⁶ For instance, the creation of an offshore complex may cause shoreline erosion on a landowner's property. As a result, he may file a private suit for damages against the proponents of the island.

In such a law suit, the plaintiff may seek either injunctive relief (i.e., a court order demanding the proponents to stop the damaging action) or money damages. Many jurisdictions allow the plaintiff to sue for both forms of relief. The success of attaining either form of relief depends on the interests involved. Generally, money damages are more successful for the plaintiff, since injunctive relief involves a major shutdown of the defendant industry.⁶⁸

Basically, the plaintiff may sue on any of the following legal theories:

- (1) Nuisance: This action necessitates proof that the pollution complained of is so frequent and noxious that it has a propensity to cause harm and that it is the proximate cause of the plaintiff's damages.
- (2) Trespass: For this action, the plaintiff must prove that the proponent illegally, without any expressed or implied consent, entered onto his property or in some way, intruded on his use and enjoyment of his property.

(3) Negligence: The plaintiff must prove that the proponents violated a standard of care which "any reasonable" person would not have violated.

(4) Strict Liability: The showing of a specific act by the proponents is conclusive proof of a violation.

Each of the above theories requires that the plaintiff sustain the difficult burden of proving the proponents' illegal act and the damage suffered; however, with the concurrent ecological concerns, the burden of proof for the plaintiff is more conclusive if some significant evidence is shown.

Environmental laws constitute a potentially volatile area of litigation. Many successful law suits have been brought against major industrial corporations.⁷⁰ Moreover, courts have allowed these plaintiffs to show that defendant industries violated certain emission limitations or other standards in various environmental laws.⁷¹ Such evidence constitutes significant proof of the plaintiff's claim. Therefore, those facilities, which are subject to various environmental laws such as the NEPA, FWPCA, and the CAA, may be checked by affected private individuals as well as governmental administrators.

Another form of litigation which the proponents of the offshore complex may incur includes public suits. Such law suits are generally brought by a class of individuals, who sue for the benefit of the public.⁷² Initially, such groups of individuals faced the problem of "standing," which necessitates the plaintiff to have incurred an "injury in fact." However, many jurisdictions liberally defined "injury in fact" to include "aesthetic, conservational or recreational interests of the general public."⁷³

Like the individual plaintiffs in private suits, the group in a public suit bears the burden of proving that the facility, by some act, caused the damage in question. Also, the group may sustain this burden by showing that the defendant facility:

- (1) violated a specific legislated or administratively promulgated standard; or,
- (2) performed some objectionable activity under either the nuisance or negligence theories.⁷⁴

Yet the group, like the private citizen, faces a difficult task of proving the facility's error. Often this task necessitates the employment of technologists and expert witnesses who will substantiate the claim. Additionally, the group

must show that some adverse effect has or will result from the violation;⁷⁵ however, the growing number of jurisdictions "shift the burden of proof" to the defendant facility after the plaintiff group proves that a violation was committed.⁷⁶

In short, the best legal antidotes for this hazard are preparation and close adherence to the statutes and regulations. The proponents should anticipate all possible detrimental ramifications of the complex and prepare contingency plans for these possible occurrences. Ultimately, the complex should constitute such a significant benefit to society that the social and financial costs of thwarting its operation through injunctive relief or extensive monetary relief would be more expensive. If the proposed offshore complex is designed for a highly beneficial and essential use, and adequate precautions are observed during its planning and construction, then the possibility of staggering legal suits should be remote.

INSTITUTIONAL ISSUES

Licensing Procedure

Presently the U. S. Army Corps of Engineers is responsible for granting Construction and Operating permits for artificial structures on the Outer Continental Shelf. In order to grant such permits the Corps must submit the proposal for review to government agencies with responsibility in their respective functional areas. The following list represents (1) those federal departments/agencies which would be involved if a proposed offshore complex were to include a deepwater port and (2) those topics which would require consideration:

DEPARTMENTS

- 1) Commerce
- 2) Defense
- 3) Interior
- 4) State
- 5) Transportation

AGENCIES

- 1) Bureau of Land Management
- 2) Bureau of Outdoor Recreation
- 3) Bureau of Sport Fisheries and Wildlife
- 4) Coast Guard
- 5) Corps of Engineers
- 6) Council of Environmental Quality
- 7) Environmental Protection Agency (EPA)
- 8) Geological Survey

- 9) Interstate Commerce Commission (ICC)
- 10) Marad
- 11) National Oceanic and Atmospheric Administration (NOAA)
- 12) National Park Service
- 13) Navy
- 14) Office of Land Use and Water Planning
- 15) Office of Pipeline Safety

TOPICS

- 1) biologic life
- 2) bonding
- 3) climate
- 4) commercial fishing
- 5) deepwater port operations
- 6) dredging/filling
- 7) economic analysis
- 8) effects on shoreline
- 9) environmental concerns
- 10) fee schedule
- 11) geology
- 12) international careers
- 13) law enforcement (civil/criminal)
- 14) maritime technology
- 15) national security
- 16) navigation
- 17) navigation aids
- 18) navigation operations
- 19) ocean currents
- 20) ocean dumping
- 21) outdoor recreation
- 22) pipeline construction (land/water)
- 23) pipeline safety
- 24) platform design and construction
- 25) platform safety
- 26) pollution (air/water)
- 27) salinity/temperature
- 28) siting
- 29) tariff-user rates
- 30) vessel operations safety
- 31) wave size
- 32) zoning for land installations

Table IV-II summarizes the primary governmental agencies and their environmental responsibilities. With so many agencies and departments involved in the procedure, it is no wonder that for the New Jersey Offshore Atlantic Generating Station # 1, 46 permits will be needed between 1972 and 1979 from more than a dozen federal, state, and municipal agencies.

TABLE IV-II
PRIMARY AGENCIES AND THEIR ENVIRONMENTAL RESPONSIBILITIES

Executive Agencies	Applicable Acts	General Duties	Assisting Agencies
White House Office	Executive Order, NEPA	Overall Policy Agency Coordination	
Office of Management and Budget	Budget and Accounting Act	Budget, Management, Agency Coordination	
Council on Environmental Quality	NEPA	Environmental Policy, Agency Coordination, Environmental Statements	EPA, NOAA
Federal Energy Office	Executive Order No. 11748	Energy Policy, Petroleum Allocation, Resource Excavation	EPA, NOAA
Dept. Health, Education and Welfare	NEPA	Health, Social Assessment	EPA, Customs
Environmental Protection	NEPA, FWPCA, ODA, CAA	Air/Water Pollution, Solid Waste, Radiation, Noise, Toxic Substances	Customs, NOAA, GS
Dept. of Justice	NEPA, FWPCA, ODA	Environmental Litigation	EPA, CORPS, BLM, GS
Dept. of Agriculture	NEPA	Forestry, Soil Conservation	EPA, GS
Dept. of Defense	FWPCA, NEPA, ODA, CAA	Civil Works Construction, Dredge and Fill Permits, Pollution Control from Defense Facilities	CORPS, Coast Guard, EPA, Customs, NOAA, GS
Nuclear Regulatory Commission	NEPA, AEA	Nuclear Safety, Radio- active Waste Disposal	EPA, Customs, GS

TABLE IV-II (Cont.)

PRIMARY AGENCIES AND THEIR ENVIRONMENTAL RESPONSIBILITIES

Executive Agencies	Applicable Acts	General Duties	Assisting Agencies
Dept. of State	NEPA, OCSA, FWPCA	International Environment	Customs, Coast Guard, GS
Dept. Of Commerce	CZMA, FWPRA, NHPA	Oceanic and Atmospheric Monitoring and Research	EPA, NOAA, GS
Dept. of Labor	NEPA	Occupational Health, Enforcement	EPA
Dept. of Housing and Urban Development	NEPA	Housing, Urban Planning, Parks	Dept. of Commerce
Dept. of Transportation	NEPA, FWPCA, ODA	Mass Transit, Roads, Airplane Noise, Oil Pollution, Vehicle Emissions, Enforcement	Coast Guard, Corps

ABBREVIATIONS

AEA	Atomic Energy Act
AFCA	Anadromous Fish Conservation Act
BLM	Bureau of Land Management
CAA	Clean Air Act
CORPS	U.S. Army Corps of Engineers
CZMA	Coastal Zone and Management Act
EPA	Environmental Protection Agency
FWCA	Fish and Wildlife Coordination Act
FWPCA	Federal Water Pollution Control Act
FWPRA	Federal Water Project Recreation Act
GS	U.S. Geological Survey
NCA	Noise Control Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
OCSA	Outer Continental Shelf Act
ODA	Ocean Dumping Act (Marine Protection, Research, and Sanctuaries Act)

Necessity for New Laws

The construction of an offshore complex under present regulation would suffer from the twin constraints of time and money. Licensing alone of the complex and of its functions could last a decade. The Deepwater Port Act of 1974 has set a precedent on how to reduce the licensing time significantly. The Act appoints a single agency, the Department of Transportation, for licensing and construction of deepwater ports, and establishes a timetable for action on a license of 11 months that includes application, environmental impact statement, hearings, and final action by federal agencies.⁷⁹ A similar one-window stop would be imperative for the licensing of an offshore complex and of its functions.

The Deepwater Port Act of 1974 establishes an additional precedent by providing adjacent coastal states with the right to veto any deepwater port proposed to be licensed under the Act.⁸⁰ An "adjacent coastal state" means any coastal state which would be (1) directly connected by a pipeline to a deepwater port, (2) located within 15 miles of the proposed port, or (3) threatened with a possible oil spill from the port.⁸¹ It seems likely, even in the absence of a deepwater port on an offshore complex, that the precedent of "adjacent coastal state" veto over a proposed complex located within 15 miles of that state, would carry over in a proposed "offshore Artificial Island Complex Act (hereafter called 'Island Act')."⁸² But this would only ratify the de facto veto of adjacent coastal states over offshore facilities because of their jurisdiction over onshore facilities, without which the offshore construction and operation could not proceed.

Another precedent possibly affecting an Island Act may have been set by the 1976 amendment to the Coastal Zone Management Act.

The measure called the Coastal Energy Impact Bill authorizes Federal financial assistance to build roads, schools, hospitals, sewage systems and water purification facilities for communities on the coasts of the oceans and Great Lakes whose populations might expand because of energy projects.

The measure . . . also specifies that any offshore energy activity by petroleum and gas companies must conform to a locality's ocean management plan. In short, this clause, at least theoretically, give municipalities the right to veto energy--exploration activity that it may feel would harm the local environment.⁸²

The Coastal Energy Impact Bill further accentuates a trend established by the Deepwater Port Act. Taken together, they seem to indicate that if Congress were to pass an Island Act it would grant both state and local governments the right to veto any proposed complex that might harm their environment. But Congress would also authorize Federal Funds to cushion some impacts that the proposed complex might have on the municipality.

It may be futile to speculate as to who the coordinating agency might be under a proposed Island Act, because the results may vary with changing constellations of power. But probably the eventual choice will be influenced by the intended uses of the offshore complex. In the case of a transportation/energy island the prime candidate would be the Department of Transportation, especially if the island included a deepwater port. In an alternative energy/transportation mode, with emphasis on offshore oil and gas production, the choice might well fall on the Department of the Interior.

Should the proposed Island Act be neutral or non-specific concerning the intended offshore functions then one can envisage two further possibilities. If the complex were financed as a public work, the task would clearly fall on the Corps of Engineers, especially if its jurisdiction under the Rivers and Harbors Act was extended to the proposed economic zone of 200 miles. In the absence of major public financing the responsibility might be given to the National Oceanographic and Atmospheric Administration in the Department of Commerce. Finally, in the absence of agreement among competing agencies a compromise might be reached to create a new independent agency.

Construction Time

Among other factors, the construction time will vary with the intended uses of the complex and the degree of public financing involved in the project. Figure 4-1 gives a rough estimate of the time involved if the project were carried out by the Corps of Engineers. Column (a) shows the Corps of Engineers analysis of average time needed for the planning and construction of Civil Works projects.⁸³ Column (b) changes the construction time from 2 years 8 months to the probable time required to construct an offshore complex and its superstructure. This is estimated to be 7 years for the dike and fill construction and 3 more years for completion of the superstructure. For dike and polder construction, the times would probably be 5 years each for the construction of

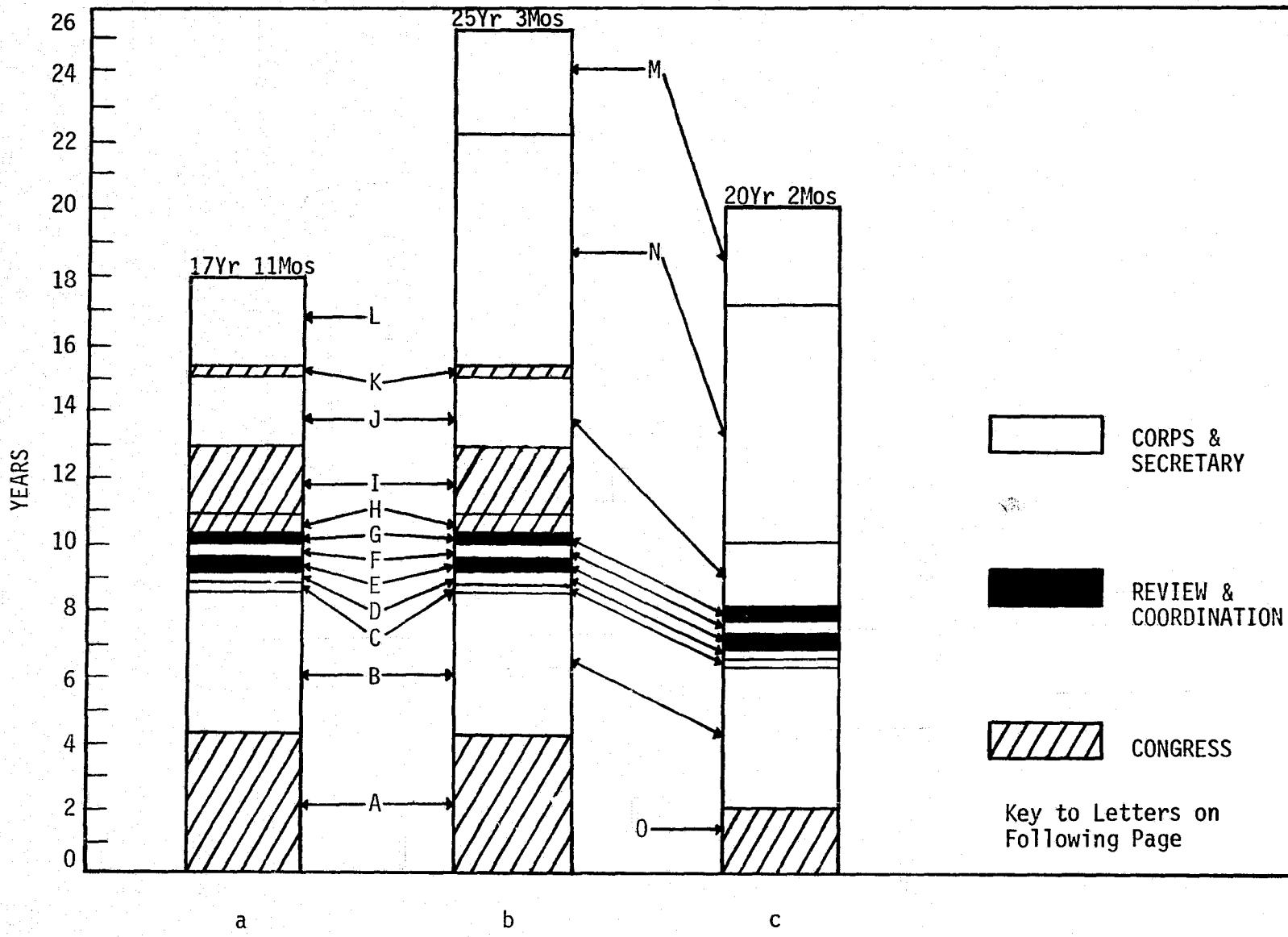


FIGURE 4-1

ESTIMATED SCHEDULE FOR AN ARTIFICIAL ISLAND

KEY TO FIGURE 4-1

- A 4 YRS. 4 MOS. AWAITING FUNDS FOR STUDY INITIATION
- B 4 YRS. 6 MOS. DISTRICT OFFICE STUDY & REPORT--INCLUDES TIME FOR PROCESSING OF LICENSES AND PERMITS
- C 2 MOS. DIVISION OFFICE REVIEW
- D 3 MOS. BOARD OF ENGINEERS REVIEW
- E 6 MOS. INTERAGENCY COORDINATION
- F 4 MOS. SEC/ARMY REVIEW
- G 3 MOS. OMB REVIEW
- H 7 MOS. AWAITING AUTHORIZATION
- I 2 YRS. 1 MO. AWAITING INITIAL ENGINEERING FUNDINGS
- J 2 YRS. 2 MOS. ADVANCED PLANNING & DESIGN
- K 1 MO. AWAITING INITIAL CONSTRUCTION FUNDING
- L 2 YRS. 8 MOS. CONSTRUCTION
- M 3 YRS. CONSTRUCTION OF ISLAND FUNCTIONS
- N 7 YRS. CONSTRUCTION
- O 2 YRS. WAITING OFFSHORE ISLAND LEGISLATION--BASED ON TIME REQUIRED TO PASS THE DEEPWATER PORT ACT OF 1974.

the complex and its superstructure. Column (c) presupposes the enactment of an Island Act and the institution of a financing mechanism other than public works appropriation. The elimination of such projects from the federal budget can result in time savings in excess of five years, which would otherwise be spent waiting for congressional appropriations.

Political Support

It is conceivable that private enterprise could obtain the necessary funds and build an offshore complex under present laws and regulations, but the fact remains that the private sector has failed to do so, that various proposals have not proceeded beyond the feasibility study phase, and that the main reason for this lack of progress is that artificial island complexes are, or are perceived to be, economically unattractive. It follows that the first substantial, large-scale artificial island complex off the United States shore will require considerable public and private support.

Government support for offshore facilities should consist of a favorable regulatory climate and of financial assistance. As previously discussed, the most effective legislation would be an Island Act which would either accompany or amend the Deepwater Port Act of 1974. Under normal circumstances, and lacking private support, Congress rarely legislates on contingent needs. The likely extension of national jurisdiction over the seas arising from the probable changes in the international law of the sea will force a revision of national ocean policy, which should include some provisions for artificial offshore island complexes. This fortuitous coincidence hardly will extend to financial assistance, unless there is sufficient private and public support for the activities to take place on a proposed island. Taken by itself, the complex would have to compete with more popular public works projects. While such public undertakings as the Tennessee Valley Authority have employed a great number of unskilled laborers, the construction of an offshore complex is not expected to provide similar employment opportunities and thus would probably not be an adequate tool for the implementation of national or regional manpower policies.

The following paragraphs will describe the potential for government support of specific functions which could be provided on offshore complexes. The functions discussed are deepwater ports, airports, and energy production.

Deepwater Ports. At the present time the Department of Transportation (DOT) is the only Executive Branch organization with a substantial interest in an offshore artificial complex. The Coast Guard has been assigned the responsibility of administering the Deepwater Port Act of 1974. At the time of writing, the Coast Guard has no pending applications beyond a single point mooring system along the Gulf Coast. Since additional deepwater facilities have been deemed necessary, the DOT would probably favor the provision of a port as a part of an offshore complex. Should the proposed port handle cargo rather than oil, it would require an amendment to the Deepwater Port Act.

Airports. As stated earlier in the chapter, the Federal Aviation Administration is charged with the responsibility of developing an airport system for the United States. It also determines the eligibility for funding under the Airport and Airways Trust Fund under the Airport and Airway Revenue Act of 1970.⁸² As such, the FAA could authorize federal financing up to 50 percent of an offshore airport if it found it in the national interest to do so. But this would hardly seem to be the case in the near future. The air terminals at New York City and Washington, D.C., which are among the most congested in the country, have considerable unused traffic capacity at both John F. Kennedy and Dulles. The recent CAB ruling which increases the number of gateways for transatlantic flights, promises to reduce traffic at those terminals further. While the FAA might have no particular incentive to champion major offshore terminal facilities, it would probably assist in the development of an airport for general access and local traffic, should an offshore complex be developed.

Energy Production. The Department of the Interior includes the Bureau of Land Management, the Geological Survey, the Bureau of Sport Fisheries and Wildlife, the Office of Oil and Gas, and the Bureau of Outdoor Recreation. Presently, some of these organizations might have a peripheral interest in an offshore artificial island complex, but none could make a convincing case of the need for public assistance to finance an offshore complex. If enough offshore oil and gas were found to justify a permanent offshore island, and if the oil

and gas companies were unwilling to pay the full cost of its construction, Interior might support some government assistance for that purpose.

The Energy Research and Development Administration (ERDA) has few ocean-specific projects that could warrant the cost of constructing an offshore complex. The few projects that are ocean-specific (such as ocean thermal energy conversion, tide or wave energy conversion) are also site specific. These sites would rarely coincide with the presumed location of a transportation oriented offshore complex in the Mid-Atlantic region. But a case might be made for ERDA (together with the Nuclear Regulatory Commission) to favor government assistance for an offshore complex that would spread or eliminate the breakwater cost for an offshore nuclear or conventional fuel power plant park.

The Federal Energy Administration (FEA) could be expected to support all energy-related activities on an offshore complex that would improve the United States' energy posture. The FEA, together with the Departments of State and Defense, would support offshore facilities that would decrease the likelihood and/or effectiveness of any future oil embargo of the United States. Thus, a deepwater port would mitigate possible transportation bottlenecks by reducing the number of tankers required to supply the United States. A major refinery would increase the flexibility of domestic oil companies in their international distribution of oil products. An offshore facility with below sea-level tanks which are integral to the complex would also provide excellent storage for major oil stockpiling.

The FEA would also approve the use of an offshore complex to facilitate the production of offshore oil and gas, and as a proponent of energy independence, it would strongly support offshore nuclear power plants, since they would encourage the substitution of domestic uranium for foreign oil as a source of energy.

Private Interests

Having examined the probable support of various federal agencies for government assistance for an offshore complex with a Transportation/Energy emphasis, let us now consider the possible support of some private interests groups. This support could consist of financial commitments to invest in their respective insular activities and, perhaps, in the construction of the

offshore complex as well. It would certainly include lobbying for substantial government assistance.

Airlines. It has been shown that presently there is no need for an additional major airport on the east coast, and that if a future need should arise there is no compelling reason to incur the additional cost of locating that airport offshore. Should a compelling reason become evident and warrant public construction funds, it would still require the financial ability of the airlines to invest in terminal facilities. This, in turn, depends both on government regulations of the industry, and the state of the economy. The present financial situation of the industry seems to preclude such investment but this situation could conceivably change in the future.

Oil Companies. At the present time there are two types of oil-related facilities that could be located on an offshore complex: a deepwater port to serve the Mid-Atlantic area and a refinery to supply oil products to the Northeastern states. Over the past decade numerous attempts have been made by oil companies to locate refineries on the Northeastern coast but none succeeded because of private and public opposition. Lacking permission to site a refinery close to its market, the oil companies decided to increase their refining capacity on the Gulf Coast, to provide crude oil to the refineries by means of single point mooring deepwater ports and to ship the oil products to the Northeast by pipelines.

Electric Utilities. Currently, the electric utilities are thrust in the forefront of the national debate over the proper equilibrium between energy, economy, and the environment. All agree that the production of abundant, cheap, safe, clean electric power, preferably from domestic energy sources, cannot be attained with present technology, but many disagree on the proper trade-offs between these factors. Several groups have tried to influence the outcome with the means at their disposal. Perhaps the most effective strategy has been the denial of sites for the construction of new power plants. Where practicable, the concept of an offshore power plant may provide an acceptable compromise among opposing interest groups at the national, state and local levels. Since the siting of power plants on offshore facilities would spread the significant cost of a breakwater among several users, one could anticipate that electric utilities would support government assistance for the construction of multi-

purpose offshore complexes.

POLITICAL CHARACTERISTICS

In order to make the offshore complex a reality, the idea must be sold to several groups--politicians on the federal, state, and local levels; the people of the impacted area; the United States population as a whole; and, any other nation which may feel threatened or imposed upon by the chosen location.

Community acceptance can be accomplished by initiating a public information program through the media and by conducting public meetings incorporating:

- (1) basic functions and objectives;
- (2) factual data-jobs, costs, requirements;
- (3) detailed cost-benefit analysis of the project; and,
- (4) alternatives if no action is taken.⁸⁵

The public should be involved, and any changes, modifications, or deletions resulting from their input should be considered and incorporated if possible. The revised program must then be represented to the public to obtain their support. As the project progresses toward completion, periodic progress reports should be issued through the media.

Since adversely affected areas will probably generate most of the opposition to a proposed offshore complex, a plan to allow these areas to receive a higher percentage of the Lease and Royalty Payments than the rest of the nation is probably necessary.⁸⁶ The Coastal Energy Impact Bill is a step in this direction.

The international effect of an offshore complex will be minimal unless its location threatens another nation either directly or indirectly by affecting shipping lanes, fishing rights, ecological disruption, military advantage, or territoriality.

LIABILITY AND INSURANCE

Possible ownership modes for an offshore island complex include:

- (1) Private: individual or corporate
- (2) Governmental: local, state, or federal
- (3) International: bi-national and multi-national
- (4) Combinations of 1, 2, and 3 are also probable
- (5) User ownership of specific locations on an offshore complex.

Modes of ownership may vary depending on structural factors of design. Thus, a floating or moored structure may lend itself to a user-leased arrangement with the owner being a corporate or governmental body, whereas land space on either dike and polder or dike and fill island probably would be sold to users in lots much like land on natural islands (or on the mainland for that matter).

Liability is contingent upon ownership. Government entities typically assume limited liability when a private contractor is engaged in an activity on its behalf.⁸⁷ The Federal Tort Claims Act,⁸⁸ waives the immunity of the United States for the negligent acts of government employees. Insurance against liability for an offshore complex must cover:

- (1) the platform or structure; as well as,
- (2) the facilities of the various users.

Insurance coverage for a user such as an airport operator or refinery owner would be handled by the owner/operator of a facility. The terms of such insurance would parallel similar onshore facilities; the premiums, however, would probably be higher.⁸⁹ The remainder of this discussion does not further consider insurance by a specific operator/owner on an island facility.

Insurance would be necessary for the complex or platform as a structure or an entity. Such insurance would depend on mode of ownership. Government bodies usually act as self-insurers; however, a question arises about insurance and liability limits when ownership is joint between a government entity and a private enterprise. Should a charter be legislated for such a complex, liability would undoubtedly be defined therein.

Insurance may take more than one form:

- (1) The government, as stated earlier, acts as a self-insurer.
- (2) Larger insurance houses frequently insure large industrial complexes. A procedure has evolved whereby several insurance firms team up to provide coverage for a given enterprise; in this manner, they all share in premium benefits and would join hands in payments for damages or injuries the extent of which might exceed the ability of any one insurer alone.
- (3) Some large corporations act also as self-insurers (e.g., oil companies).

Some questions that are relevant in this area are:

- (1) Is unlimited insurance available? If not, what is the maximum limit of available insurance?

- (2) What are the limits of liability under prevailing law?
- (3) Are the limits of liability different within the 3, 12, or 200 miles zones?
- (4) Is insurance coverage reasonably available?
- (5) Can liability of functional users of the complex be separated from that of owner/operator of the structure?
- (6) What are the forms and limits of liability for an artificial offshore structure?

Present laws do not provide adequately for liability in cases involving offshore facilities; however, forthcoming legislation would probably rectify this as seen in several pending bills such as S.521, S.1754, S.2162, HR6218, HR9293, and HR10756. Some of these bills provide for unlimited liability--even though vaguely so.⁹⁰

CONCLUSIONS

A review of the public and private sources of support for government assistance for the construction of an offshore complex reveals a large degree of fragmentation of interest. Most of these groups have some interest in the venture, an interest that varies with time. But no single group has the adequate combination of interest in the project and of financial and/or political power to serve as the prime mover and coordinator for other groups.

The generation of adequate support for the construction of an offshore complex may be provided by developments in the legal and economic areas. In the realm of law, the number of acts passed in recent years have enabled and/or clarified ocean-related activities. Further impetus should be provided by the future international treaty on the Law of the Sea, which could possibly promote the enactment of a United States "Island Act." At the same time, and independently from ocean-related legal developments, a number of offshore economic developments might interact to an extent that would generate sufficient interest and support for the construction of one or more offshore complexes.

END NOTES

- ¹ 33 U. S. C. 401 et seq.
- ² 43 U. S. C. Sec. 1333 (a) (2).
- ³ 33 U. S. C. Sec. 1518 (b).
- ⁴ 33 U. S. C. 1501 et seq.
- ⁵ 33 U. S. C. 1501 (a).
- ⁶ 49 U. S. C. Sec. 1742 et seq.
- ⁷ 49 U. S. C. Sec. 1301 et seq.
- ⁸ 49 U. S. C. Sec. 1651 et seq.
- ⁹ 49 U.S. Department of Interior, Office of Technology Assessment Ocean Assessment Program, Coastal Effects of Offshore Energy Development; Oil and Gas Systems, Interim Report to Technology Assessment Board, (March, 16, 1976), p. 3.
- ¹⁰ Id.
- ¹¹ Id. at 3.
- ¹² Id. at 13.
- ¹³ 33 U. S. C. Sec. 1504 (b) (2).
- ¹⁴ Office of Technology Assessment, *supra* note 7.
- ¹⁵ Id. at 21.
- ¹⁶ Id. at 23-25.
- ¹⁷ Gupte, Pranay, "Coastal Aid Bill is signed by Ford," *New York Times* (July 27, 1976), p. 1, col. 1.
- ¹⁸ Id. at p. 50, col. 7.
- ¹⁹ 43 U. S. C. Sec. 1333 (a) (2).
- ²⁰ 33 U. S. C. Sec. 1518 (b). Similar language can be found in the Outer Continental Shelf Lands Act of 1953.
- ²¹ 33 U. S. C. Sec. 1504 (h) (2).
- ²² Art. 1 Sec. 10, Clause 2.
- ²³ 307 A. 2d 1 (Me. 1973).
- ²⁴ 38 M. R. S. A. Sec. 541 (1970).
- ²⁵ 33 U. S. C. Sec. 1506 (a)
- ²⁶ 43 U. S. C. Sec. 1331 et seq.
- ²⁷ 15 U. S. T. 471.
- ²⁸ Robert R. Nathan Assoc., Inc., Institutional Implications of U. S. Deepwater Port Development for Crude Oil Imports, Institute for Water Resources, Report 73-4.

- ²⁹ 16 U. S. C. 145 et seq.
- ³⁰ 16 U. S. C. Sec. 1454 (b).
- ³¹ 16 U. S. C. Sec. 1455 (a).
- ³² National Environment Policy Act, 42 U. S. C. 4341, as amended (1975).
- ³³ 33 C. F. R. 209, as amended by 41 FR 5391 (1976).
- ³⁴ 33 C. F. R. Sec. 209.120 (a).
- ³⁵ 33 C. F. R. Sec. 209.120 (f) (2).
- ³⁶ 33 C. F. R. Sec. 209.120 (f) (4).
- ³⁷ 33 C. F. R. Sec. 209.120 (j).
- ³⁸ 33 C. F. R. Sec. 209.120 (s) (1-9).
- ³⁹ 40 C. F. R. 227, as amended by 39FR40018 (1974).
- ⁴⁰ 40 C. F. R. Sec. 227.1.
- ⁴¹ 40 C. F. R. Sec. 227.21.
- ⁴² 40 C. F. R. Sec. 227.22.
- ⁴³ 40 C. F. R. Sec. 227.3-31.
- ⁴⁴ 40 C. F. R. Sec. 227.61.
- ⁴⁵ 38 F. R. 12872 (1973).
- ⁴⁶ 40 C. F. R. 230 (1975).
- ⁴⁷ 40 C. F. R. Sec. 230.4-1.
- ⁴⁸ 40 C. F. R. Sec. 230.5.
- ⁴⁹ 40 C. F. R. Sec. 230.7.
- ⁵⁰ 40 C. F. R. 1510 (1975).
- ⁵¹ 40 C. F. R. Sec. 1510.2 (b).
- ⁵² Note that the overall plan includes various phases of operation: Discovery and Notification; Evaluation and Initiation; Containment; Cleanup; and Documentation, 40 C. F. R. Subpart D Sec 1510.40-45.
- ⁵³ 40 C. F. R. 112, as amended by 39F.R. 31602 (1974).
- ⁵⁴ 40 C. F. R. Secs 112.3; 112.6-7.
- ⁵⁵ 40 C. F. R. 435 (1975).
- ⁵⁶ 40 C. F. R. 435.12.
- ⁵⁷ 40 C. F. R. 419, as amended by 40 FR 21939 (1975).
- ⁵⁸ 40 C. F. R. Sec. 419.12.
- ⁵⁹ 40 C. F. R. Secs. 419.15, .16, .25, .26, .35, .36, .45, .46, .55, .56.
- ⁶⁰ 40 C. F. R. 50, as amended by 41F.R. 11253 (1976).

- ⁶¹ 40 C. F. R. Secs 50.4-.11.
- ⁶² 40 C. F. R. Sec. 50.2 (b).
- ⁶³ 40 C. F. R. 60, as amended by 41 F. R. 18498 (1976).
- ⁶⁴ 40 C. F. R. Secs. 69.22 -.29.
- ⁶⁵ 40 C. F. R. Secs. 60.100 - .106.
- ⁶⁶ 40 C. F. R. Secs 60.110 - .113.
- ⁶⁷ Hassett, Charles M., (Ed.), Environmental Law, Ann Arbor: Hutchins Hall, 1971; p. 35.
- ⁶⁸ Ibid, pp. 25-37.
- ⁶⁹ Ibid, pp. 37-38.
- ⁷⁰ Davis V. Morton, 4'69F.2d59 (10th Cir. 1972) demonstrates the trend is ever increasing environmental litigation. See B. Cohen and J. Warren, "Judicial Recognition of the Substantive Requirements of the National Environmental Policy Act of 1969," 13 B. C. Ind. and Com. L. Rev. 685 (1972). See also, United States V. Causby, 328 U. S. 256 (1946), where government planes made plaintiff's land value less.
- ⁷¹ Charles M. Hassett, p. 40.
- ⁷² Ibid, pp. 47-50.
- ⁷³ Dolgin, E. L., and Guilbert, T. G. P., (Eds.), Federal Environmental Law, St. Paul: West Publishing Co., 1974, pp. 283-84.
- ⁷⁴ Charles M. Hassett, p. 47.
- ⁷⁵ See, North Anna Environmental Coalition V. VEPCO, 5 ELR 10188 (D. C. filed 1975), where the coalition proved violations committed by VEPCO. Scientists' Institute for Public Information V. Atomic Energy Commission, 481 F.2d 1079 (D. C. Cir 1973) where the court held that "injury in fact" may consist of a denied access to information required to be generated under NEPA. Sierra Club V. Mason, 351 F. Supp. 419 (D. Conn. 1972), where the court allowed the plaintiff to make general allegations of adverse affects.
- ⁷⁶ Charles M. Hassett, pp. 50-54.
- ⁷⁷ Bragaw, Louis K., et al., The Challenge of Deepwater Terminals, Lexington: D. C. Heath and Company, 1975, pp. 97-99.
- ⁷⁸ David Maniago, Licenses and Permits, a listing of Federal, State and City licenses, permits, certifications, and approvals required to construct and operate the Facility which will manufacture floating nuclear plants plus those permits needed to transport and operate the Atlantic # 1 Generating Station by Offshore Power Systems, Jacksonville, Fla., (1976).
- ⁷⁹ 33 U. S. C. Sec. 1504. The 11 month figure can be arrived at by adding together all of the established times set forth in Sec. 1504.
- ⁸⁰ 33 U. S. C. Sec. 1508 (b) (1).

- ⁸¹ 33 U.S. C. Sec. 1502 (1).
- ⁸² Gupte, Supra note 15, p. 1 col. 1.
- ⁸³ Bragaw, supra note 75, p. 100.
- ⁸⁴ 49 U. S. C. Sec. 1742 et seq.
- ⁸⁵ First International Conference on Offshore Airport Technology, Proceedings of the Conference, Vo. 2, p. 63, American, Institute of Aeronautics and Astronautics, New York, NY, 1973.
- ⁸⁶ Massachusette Institute of Technology, Sea Grant, 1973. World Energy and the Oceans, Report Number MITSG 74-7, Index 74-607, National Technical Information Service, pp. 12-26, Springfield, Va. 174.
- ⁸⁷ e.g. Gowdy v United States, 412 F. 2d 525 (6th Cir. 1969); Roberson v United States, 382 F. 2d 714 (9th Cir. 1967).
- ⁸⁸ 28 U. S. C. Sec. 1346 (b).
- ⁸⁹ Maier, Richard L., The Settlement of the Seas I: The Prospective Demands for Aquatic Surface, School of National Resources, University of Michigan, January 1964, p. 1.
- ⁹⁰ Office of Technology Assessment, supra note 7, pp. 26-29.

REFERENCES

REFERENCES

The following entries have been cited in this report. Other materials were also used for background and have been included in the supplemental Bibliography which follows this section. Entries are listed by the author's last name. Where no author is given, entries are listed by the key word in the title.

Avery, W.H., et al., "Executive Summary-Maritime and Construction Aspects of Ocean Thermal Energy Conversion (OTEC) Plant Ships," Laurel, Maryland: The John Hopkins University, Applied Physics Laboratory, APL/JHU, SR 76-1A, April 1976.

Bedore, R.L., "Large Floating Platform Technology: A Review," Transactions of the ASME, Journal of Basic Engineering, The American Society of Mechanical Engineers, (December 1972), pp. 834-840.

Bragaw, Louis K., et al., The Challenge of Deepwater Terminals. Lexington, Massachusetts: Heath and Co., 1975, pp. 97-99.

Coastal Effects of Offshore Energy Development; Oil and Gas Systems, U.S. Department of Interior, Office of Technology Assessment, Ocean Assessment Program, March 16, 1976, pp. 3, 13, 21, 23-25, 26-29.

Craven, J.P., "Present and Future Uses of Floating Platforms," Oceanus, (Fall 1975), pp. 67-71.

Davis v Morton, 469 F. 2d 59 (10th Cir., 1972).

Dolgin, E.L. and Guilbert, T.G.P., ed., Federal Environmental Law, St Paul, Minnesota: West Publishing, 1974, pp. 248, 256, 379, 653, 658, 683, 1060, 1104, 1146.

Environmental Assessment Notebook Series, Notebook 2: Social Impacts, and Notebook 3: Economic Impacts, U.S. Government Printing Office No. 050-000-00109-1, (1975).

Evaluation of Construction Methods for Offshore Airports, Federal Aviation Administration, Final Report, Contract FA-69-WA-2073.

First International Conference on Offshore Airport Technology, Proceedings of the Conference, Vol. 2, New York: American Institute of Aeronautics and Astronautics, 1973, p. 63.

Gowdy v United States, 412 F 2d 525 (6th Cir., 1969).

Greenberg, M.R., Krueckeberg, D.A., and Mautner, R., Longrange Population Projections for Minor Civil Divisions: Computer Programs and User's Manual, New Brunswick, New Jersey: Center for Urban Policy Research, Rutgers University, May 1973.

Grey, J., "Proceedings-First International Conference on Offshore Airport Technology," sponsored by the American Institute of Aeronautics and Astronautics; Federal Aviation Administration; and International Water Resources Association, Bethesda, Maryland, April 29-May 2, 1973, Vols. I and II.

Gupte, Pranay, "Coastal Aid Bill is Signed by Ford," New York Times (July 27, 1976), p. 1, Col. 1, p. 50, Col. 7.

Hanson, J.A., (Program Manager), Hawaii's Floating City Development Program, Department of Commerce, grant SG-2-35243, March 1974, Technical Reports #1, 2, 3, 4, 5, & 6.

Hassett, Charles M., ed., Environmental Law, Ann Arbor, Michigan: Hulchins Hall, 1971, pp. 25-38, 40, 47-50, 50-54.

Helly, Walter, Urban Systems Models, New York: Academic Press, 1975, p. 57.

Holmes, E.P. (Chairman), Offshore Port Facilities, Report by State Task Force to the Commonwealth of Virginia, February 1974, (17 pages).

Institutional Implications of U.S. Deepwater Port Development for Crude Oil Imports.
IWR Report 73-4. Springfield, Virginia: National Technical Information Service, June 1973.

Isard, W., and Coughlin, R.E., Municipal Costs and Revenues Resulting from Community Growth, Boston, Massachusetts: Federal Reserve Bank of Boston, 1972.

Judicial Recognition of the Substantive Requirements of the National Environmental Policy Act of 1969, 13 B.C. Ind. and Com. L. Rev. 685 (1972).

Klepper, O.H. and Anderson, T.D., "Siting Considerations for Future Offshore Nuclear Energy Stations," Nuclear Technology, Vol. 22 (May 2, 1974) pp. 160-169.

Maier, Richard L., The Settlement of the Seas I: The Prospective Demands for Aquatic Surface, School of National Resources, Ann Arbor, Michigan: University of Michigan (January 1964), p. 1.

Maniago, David P., Licenses and Permits, Jacksonville, Florida, Offshore Power Systems, 1976.

New York Offshore Airport Feasibility Study Vol. I, U.S. Department of Transportation, Report # FAA-RD-74-184, I, December 1974, pp. 57-58.

North Anna Environmental Coalition v VEPCO, 5 ELR 10188 (D.C. filed 1975).

Offshore Terminal System Concepts, 4 Vols., U.S. Department of Commerce, Maritime Administration, Contract No. 1-35409, Executive Summary and Report, Part 1, 2, and 3, September 1972.

Perloff, Harry S., and Wings, Lowdon, Jr., (Eds.), Issues in Urban Economics, Baltimore, Maryland: John Hopkins Press, 1968, pp. 166-167.

Potential Onshore Effects of Deepwater Oil Terminal-Related Industrial Development, Vol. IV, Part Five: Appendices, NTIS No. PB 224-019, September 1973.

Rittel, Horst W. J., and Webber, Melvin W., "Dilemmas in a General Theory of Planning," Policy Sciences, Vol. 4 (1973), pp. 155-169.

Robertson v United States, 382 F 2d 714 (9th Cir. 1967).

Scientists' Institute for Public Information v Atomic Energy Commission, 481 F 2d 1079 (D.C. Cir. 1973).

Sea Port of New York Authority v Eastern Airlines, 259 F Supp. 745 (E.D.N.Y. 1966).

Shields, Mark A., "Social Impact Studies: An Expository Analysis," Environment and Behavior, Vol. 7 (September 1975), pp. 265-284.

Sierra Club v Mason, 351 F Supp. 419 (D Conn. 1972).

ORIGINAL PAGE IS
OF POOR QUALITY

Sincoff, Michael Z., and Dajani, Jarir S., (Eds.), Urban Transportation: Perspectives on Mobility and Choice, NASA Contract NGT 47-003-028, Norfolk, Virginia: Old Dominion University Research Foundation, 1974.

Strauss, A.M., Solar Sea Power Plants (SSPP)-A Critical Review and Survey, Greenbelt, Maryland: NASA, Goddard Space Flight Center, NASA-TM-X-70783, September 1974.

Substate Regionalism and The Federal System, (3 Vols.), Washington, D.C.: U.S. Government Printing Office 1973 as cited by The Environmental Assessment Notebook Series, Notebook 3: Economic Impacts, U.S. Government Printing Office, No. 050-000-00109-1 (1975).

Swatek, P. (Project Manager), Evaluation of Multi-Purpose Offshore Industrial-Port Islands: Major Research Problems and Promising Research Approaches, Study by University of Delaware, College of Marine Studies, Newark, Delaware: RANN, Grant GI-43111, Final Report May 1975.

United States Constitution, ARTICLE 1, Sec. 10, Clause 2.

United States v Causby, 328 U.S. 256 (1946).

U.S. Deepwater Port Study. 5 Vols., IWR Report 72-8. Springfield, Virginia: National Technical Information Service, August, 1972.

Virginia and the Outer Continental Shelf Problems, Possibilities and Posture, Richmond, Virginia: Commonwealth of Virginia, Council on the Environment, November 7, 1974, pp. 66-67.

White, I.L., Decision-Making for Space: Law and Politics in Air, Sea, and Outer Space, West Lafayette, Indiana: Purdue University Studies, 1970.

Wolf, C.P., (Ed.), Social Impact Assessment, Milwaukee, Wisconsin: Environmental Design Research Association, 1974.

World Energy and The Oceans, Massachusetts Institute of Technology, Report No. MITSG 74-7, Springfield, Virginia: NTIS, 1974, pp. 12-26.

Yumori, I.R., Seaward Extension of Urban Systems: Feasibility of Offshore Coal-Fired Electric Power Generation, Oceanic Foundation, Waimamalo, Hawaii: January 1975.

13 U.S.T. 2312, TIAS 5200, Ratified September 30, 1962, ARTICLE 1.

15 U.S.T. 471, TIAS 5578, Ratified June 10, 1964, ARTICLES 5(4), 8.

15 U.S.T. 1606, TIAS 5639, Ratified September 10, 1964, ARTICLES 3, 4, 10, 24(1)(a).

16 U.S.C. Sec. 145 et seq., 460, 470, 608, 661, 757, 1451-1464.

28 U.S.C. Sec. 1346(b).

33 C.F.R. Sec 209 as amended by 41 FR 5391 (1976).

33 U.S.C. Sec. 401 et seq., 1251, 1281 (g)(2), 1311 (b)(2)(B), 1316, 1321 (b)(5), 1322 (g)(h), 1401, 1411, 1501 et seq., 1502 (1), 1504, 1506 (a), 1508 (b)(1), 1518 (b).

38 FR 12872 (1973).

38 M.R.S.A. Sec. 541 (1970).

40 C.F.R. Secs. 50 as amended by 41 FR 11253 (1976), 60 as amended by 41 FR 18498 (1976), 69. 22-29 and .110-.113, 112 as amended by 39 FR 31602 (1974), 230, 227 as amended by 39 FR 40018 (1974), 419 as amended by 40 FR 21939 (1975), 435, 1510.

42 U.S.C. Sec. 1857-1858 (a), 3251-3254 (f), 4341 as amended (1975), 4901.

43 U.S.C. Sec. 1301 et seq., 1333 et seq.

49 U.S.C. Sec. 1301 et seq., 1651 et seq., 1742 et seq.

90 STAT Sec. 331.

307 A. 2d 1 (Me. 1973).

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

The following entries constitute a partial listing of useful background materials. Entries are listed by the author's last name. Where no author is given, entries are listed by the key word in the title.

Ahern, William R., Oil and the Outer Coastal Shelf: the Georges Bank Case, Cambridge, Massachusetts: Ballinger Publishing Company, 1973.

"Airport Feasibility Study for the Lake Erie Regional Transportation Authority," Dames and Moore, Under Contract to Howard, Needles, Tammen and Berfendoff, Phase I Reports, May 1974, Phase II Reports, October 1975.

"Airstorport, Genoa (Cristoforo, Colombo)," Aeroplane, Vol. 115, No. 2941, February 28, 1968, p. 19.

"An Application of Oceanographic Data in Offshore Structural Design," Society of Petroleum Engineers Journal, SPE Paper 1419, May 1966, pp. 273-282.

Anderson, A.R., "Prestressed Concrete Floating Structures, (State of the Art)," presented at The Spring Meeting of SNAME, Vancouver, British Columbia, May 1975.

Anderson, J.H., "Research Applied to Ocean Sited Power Plants for Offshore Electric Power Generation," Annual Report, January 1-December 31, 1973, Amherst, Massachusetts: University of Massachusetts.

Anderson, V.C., "Reports on Application of ARPA Platforms," Scripps Institute of Oceanography, San Diego, California, 1971.

"Another Floatable Light Tower," Engineering, Vol. 203, No. 5268, April 7, 1967, p. 534.

"Aquaports: Is The Convenience Worth The Complexity?" Astronautics & Aeronautics, Vol. 7, No. 4, April 1969, pp. 24-25.

"Arabian Pier is Built Six Miles Off Shore," Engineering News-Record, Vol. 168, No. 8, February 22, 1962, pp. 42-43.

Armstrong, E.R., "Armstrong Seadrome," U.S. Patent #1,511,153, October 7, 1924.

Atlas of the Living Resources of the Seas, The FAO, Department of Fisheries, Food and Agriculture Organization of the United Nations, Rome, Italy, 1972.

Background Papers on Seafloor Engineering, Vol. 1 and 2, U.S. Department of Commerce, NSF Grant NSF-C310, June 1975.

Bader, J., "Ocean Platforms State-of-the-Art," NSRDC Report 2779, AD 848155, National Technical Information Service, November 1968.

Bedore, R., "Floating Ocean Platforms," IEEE 1971 Engineering in the Ocean Conference, San Diego, California, September 1971.

Bedore, R., "Mobile Ocean Basing Systems (MOBS)-Motion Studies," Naval Undersea Research and Development Center TN 508, July 1971.

Belt, Robert M., "New Land Worth \$23 Million for Honolulu," Civil Engineering, September 1963, pp. 60-62.

- Biewer, F.N., "The Articulated Column Semi-Submersible Stable Ocean Platform," Offshore Technology Conference, Houston, Texas, 1971, OTC 1419.
- Biggs, R.B., "Offshore Industrial-Port Islands," Oceanus, Fall 1975, pp. 57-66.
- Blanton, J.O. (Editor), An Oceanographic Research Program for the CONTINENTAL SHELF OFF THE SOUTHEASTERN UNITED STATES, Energy Research and Development Administration, ERDA-12, UC-11, October 8-9, 1974.
- Blume, John A., and Keith, James M., "Rincon Offshore Island and Open Causeway," Proceedings of the ASCE, Journal of Waterways and Harbors Division, W.W.3, No. 1179, September 1959, pp. 61-93.
- Bonasia, J., "Artificial Islands for Industrial Ports," Water Spectrum, Vol. 7, Fall 1975, pp. 31-38.
- Bragg, Daniel M., "A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas," Part I, "Potential Economic Effects," College Station: Texas A and M University, April 1974.
- Bragg, D.M., and Bradley, J.R., "Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Coast Region," College Station, Texas: Texas A and M University, Sea Grant Program, June 1971.
- Bretschneider, C.I. (Editor), Topics in Ocean Engineering, Houston: Gulf Publishing Company, 1969.
- Browes, W.A., Sisk, D.C., and Quayle, R.G., Environmental Guide for Seven U.S. Ports and Harbor Approaches, Ashville, North Carolina: NOAA, February 1972.
- Budal, K., and Falnes, J., "Power Generation from Ocean Waves Using a Resonant Oscillating System," Marine Science Communications, 1 (3&4), 1975, pp. 269-288.
- Burton, R.A., "Down to the Seas in Concrete," Naval Research Reviews, Vol. 22, February 1969.
- "Building a Multipurpose Island in the Sea," Ocean Industry, April 1973, p. 187.
- "The Case for Coastal Airports," Aeroplane, Vol. 113, No. 2896, April 19, 1967, pp. 21-23.
- Cheney, Philip B., "The Development of a Procedure and Knowledge Requirements for Marine Resource Planning - Functional Step Two - Knowledge Requirements," TRC Report 4047-387, Hartford, Connecticut: The Travelers Research Corporation, February 1970.
- "Chicago Plans Airport-in-the-Lake," American Aviation, Vol. 32, No. 4, July 22, 1968, pp. 39-43.
- Coastal Engineering, Proceedings of the Coastal Engineering Conference, Vol. II, The American Society of Civil Engineers, June 24-28.
- Collier, A.R., and Nichols, R.C., "Floating Nuclear Plant Design," Nuclear Engineering International, Vol. 18, No. 205, June 1973, pp. 478-483.
- Colwell, R.R., et al., "Microbial Ecology and the Problem of Petroleum Degradation in Chesapeake Bay," NTIS CSCL 06/13, 1974.
- Cooper, R., and Frankel, E., "A Semi-Submerged Stable Platform as an Offshore Port," 1971 Offshore Technology Conference, Houston, Texas, Paper #OTC 1331, April 1971.

Craven, John P., and Hanson, J.A., "Hawaii's Floating City," Report for the Sea Grant Program, University of Hawaii, 1972.

Craven, J.P., et al., "A Floating Coal-Fired Power Plant for Hawaii," Marine Science Communications, 1(3&4), 1975, pp. 289-304.

Cronin, L. Eugene, et al., "Preliminary Analysis of the Ecological Aspects of Deep Port Creation and Supership Operation," IWR Report 71-10, Springfield, Virginia: The National Technical Information Service, October 1971.

Davidson, J.R., Sea Grant Program-A Report for Year of 1971-72, Honolulu, Hawaii: University of Hawaii, Miscellaneous Report, UNIHI-SEA GRANT-MR-74-02, January 1974.

"Deep Draft Vessel Port Capability on the U.S. North Atlantic Coast," Washington, D.C.: U.S. Department of Commerce, November 1971.

Deepwater Port Policy Issues, A Staff Analysis Pursuant to S. Res. 45, A National Fuels and Energy Policy Study, Serial No. 93-42 (92-77), Washington, D.C.: U.S. Government Printing Office, 1974, p. 102.

"Deepwater Ports: Issue Mixes Supertankers, Land Policy," Science, 191, August 31, 1973, pp. 825-827.

de Frondeville, Bertrand L., et al., "Foreign Deep Water Port Developments-A Selective Overview of Economics, Engineering and Environmental Factors," Alexandria, Virginia: U.S. Army Engineer Institute for Water Resources, December 1971.

The Delta Project, The Ministry of Transport and Waterstraat in cooperation with Delta Department of Rijkswaterstraat and The Netherlands Information Service, 1971.

Det Norske Veritas, "Rules for Design Construction and Inspection of Fixed Offshore Structures," Grenseveign 92, Oslo, Norway, 1974.

Devaney, J.W., III, "Key Issues in Offshore Oil," Technology Review, January 1974, pp. 21-23.

Disposal in the Marine Environment-An Oceanographic Assessment, by National Research Council, National Academy of Sciences, Washington, D.C., 1976.

Doumany, G.A., and Dyas, N.W., "Development of Oil and Gas on the Continental Shelf," Committee on Commerce, U.S. Senate, Library of Congress, April 1974.

Draft Environmental Statement related to Construction of Atlantic Generating Stations Unit 1 and 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, April 1976.

Ducsik, D.W. (Editor), "Power, Pollution, and Public Policy: Issues in Electric Power Production, Shoreline Recreation, and Air and Water Pollution Facing New England and The Nation," Rockville, Maryland, NOAA, Office of Sea Grant, Contract GH-88, June 1971.

Dugger, G.L., "OTEC/Amonia and OTEC/LH₂ Costs," Laurel, Maryland: The Johns Hopkins University, Applied Physics Laboratory, June 17, 1976.

The Economics of Deepwater Terminals, Department of Commerce, Maritime Administration, Division of Ports and Intermodal Systems, Washington, D.C.: U.S. Government Printing Office, 1972.

- Edge, B.L., and Mayer, P., "A Stochastic Model for the Response of Permanent Offshore Structures Subject to Soil Restraints and Wave Forces," Office of Water Resources Research, U.S. Department of the Interior, Report No. WRC-0269, April 1969.
- Edwards, and Zupnick, "Floating Powerplant to Support Submerged Offshore Operations," 1969 Offshore Technology Conference, Houston, Texas, Paper #OTC 1131.
- "Environmental Guidelines for the Civil Works Program of The Corps of Engineers," IWR Report 70-5, Alexandria, Virginia, U.S. Army Corps of Engineers, November 1970.
- "Environmental Report Parts I and II, for Atlantic City Nuclear Power Plant," Jacksonville, Florida: Offshore Power Systems, 1973.
- Evans, J.H., Ocean Engineering Structures, Vol. I (course notes), Cambridge: The M.I.T. Press, Massachusetts Institute of Technology, May 1969.
- "Final Environmental Impact Statement Deepwater Ports," Vol 1 and 2, United States Department of Interior, April 1974.
- "Final Environmental Impact Statement Maritime Administration Tanker Construction Program," United States Department of Commerce, N.T.I.S. Report No. EIS730725-F, May 1973.
- Finzi, L.A., "Major Electric Equipment Cost Figures for Solar Sea Power Plants," National Science Foundation, Research Applied to National Needs (RANN), Under Grant No. GI-39114, October 31, 1974.
- Fisher, A., "Energy from the Sea-waves, tides, and currents," Popular Mechanics, May 1975, pp. 69-73.
- Fisher, J.S., Gulbrandsen, L.F., and Goldsmith, V., "Analytical Prediction of Shoreline Erosion," Proceedings, Ocean Engineering III, ASCE Speciality Conference, Newark, Delaware, June 9-12, 1975.
- "Floating Airport Idea Revived for Postwar Construction," Engineering News-Record, Vol. 130, No. 20, May 20, 1943, p. 724.
- "Floating Airport: Key to Inter-City Traffic," Astronautics and Aeronautics, Vol. 5, No. 9, September 1967, pp. 46-51.
- "Floating Airports Planned for Transocean Travel," Engineering News-Record, Vol. 102, No. 20, May 16, 1929, p. 794.
- "Floating Landing Mats for Aircraft," Engineering, Vol. 202, No. 5228, July 1, 1966, p.9.
- "Floating Nuclear Power Plants Near Reality," Ocean Industry, September 1971, p. 60.
- "Floating Runways," Engineering News-Record, Vol. 176, June 16, 1966, p. 156.
- Flory, J.F., "Oil Ports on the Continental Shelf," Oceanus, Fall 1975.
- "Foreign Deep Water Port Developments: A Selective Overview of Economics, Engineering and Environmental Factors," 3 Vols., IWR Report 71-11, Springfield, Virginia: NTIS, December 1971.
- Frair, L., and Devine, M., "Economic Optimization of Offshore Petroleum Development," Management Science, Vol. 21, No. 12, August 1975, pp. 1370-1379.

Fulton, R.P., Marine Pollution Abatement Laws, Problems, and Commentary Concerning Large Vessels, New York: The Society of Naval Architects and Marine Engineers, 1971.

Gagliano, S.M., and Day, J.W., Jr., "Environmental Aspects of a Superport off the Louisiana Coast," Report 1, Louisiana Superport Studies, Center for Wetland Resources, 1972.

Gerwick, B.C., Jr., (Ed.), Proceedings of the Conference on Concrete Ships and Floating Structures, University of California Berkeley, 1976.

Gerwick, B.C., Jr., "Utilization of Prestressed Concrete in Artic Ocean Structures," First International Conference on Port and Ocean Engineering Under Artic Conditions, Trondheim, Norway, 1971.

Glomten, L.R., "Sea-Logs, A Stable Ocean Platform Concept," 1969 Offshore Technology Conference, Houston, Texas, Paper #OTC 1134.

Goldsmith, V., and Colonell, J.M., "Results of Ocean Wave-Continental Shelf Interaction," Proceedings of the 14th Coastal Engineering Conference, Denmark, Published by American Society of Civil Engineers, June 1974.

Goldsmith, V., "Shoreline Waves, Another Energy Crisis," Paper presented at The Coastal Society, First Annual Conference, Arlington, Virginia, November 24, 1975.

Habercom, Guy E., Jr., "Supertankers and Superports, A Bibliography with Abstracts," Springfield, Virginia: NTIS, November 1974.

Hakman, Peter A., "Environmental Protection for Offshore Marine Terminals," Ports and Harbors, Vol. 18, No. 2, February 1973.

Hammon, Alfred, Carroll, Matthew, and Muller, Gerhardt, "Ocean Petroleum Tanker Size and Traffic Forecast - Port of New York 1975," The Port of New York Authority, May 1970.

Hann, Roy W., and James, Wesley P., "A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas, Part II: Environmental Considerations," College Station: Texas A and M University, April 1974.

Hargis, W.J., "An Assessment of Estuarine and Nearshore Marine Environments," Gloucester Point, Virginia: Virginia Institute of Marine Science, March 1976.

Harlow, E.H., "Offshore Floating Terminals," Paper, ASCE Session on New Developments in Marine Transportation, July 1970.

Harlow, E.H., "Offshore Floating Terminals," Journal of the Waterways, Harbors and Coastal Engineering Division, Proceedings of The American Society of Civil Engineers, Vol. 97, August 1971, pp. 531-548.

Harlow, E.H., "Structures for Loading and Discharging Very Large Ships Offshore," Proceedings, PIANC, Paris, 1969.

Harlow, E.H., "Trends in Mammoth Tanker Terminals," World Petroleum, June 1970.

Harlow, E.H., and Small, S., "Problems Arising from the Use of Very Large Ships in Connection with Structures for Loading and Discharging Offshore," PIANC, Brussels, 1969.

Heronemus, W.E., "A Proposed Ocean Thermal Energy Conversion Systems Program Plan (The OTECS Plan)," University of Massachusetts, Amherst, Massachusetts, Energy Alternatives Program, March 1975.

- Hoffman, J.F., "Man-made Islands Can Solve Many of Our Problems," Ocean Industry, February 1970.
- Hollings, E.F., "National Ocean Policy: Priorities for the Future," Oceanus, Fall 1975, pp. 9-19.
- Holmes, J.F., and Fink, C.R., "Tuned Floating Platform for Offshore Power Facilities," Mechanical Engineering, October 1972, pp. 31-42.
- Horn, F., (Ed.), "Offshore Power Systems-Floating Nuclear Plants (Plant Design Report)," Oak Ridge, Tennessee: U.S.N.R.C., FIND-STN-50437, October 1974.
- Howe, R.E., "Design and Operations Requirements for Oil Transfer Offshore Terminals," Conference on Ocean Oil Spills, NATO Committee on Challenges of Modern Society, Brussels, November 2-6, 1970.
- Hudson, R.Y., "Laboratory Investigation of Rubble-Mount Breakwaters," Journal of the Waterways and Harbors Division, ASCE, Vol. 85, No. WW3, September 1959, pp. 93-121.
- "Institutional Implications of Deepwater Ports," Washington, D.C.: U.S. Army Corps of Engineers, June, 1973.
- "Interim Report - Atlantic Coast Deep Water Port Facilities Study," Philadelphia: U.S. Army Corps of Engineers, June, 1973.
- "Investigation of a Submerged Attenuation System for Offshore Deepwater Oil Terminals," U.S. Department of Commerce, Contract 4-37028, December 1974.
- James, W.P., Hann, R.W., Jr., and Slowey, F., "Effects of an Offshore Crude Oil Unloading Terminal on the Marine Environment," MTS Journal, Vol. 9, No. 1, January 1975.
- "Jet Airport in Boston Harbor," Civil Engineering, September 1968, p. 55.
- Kalis, Bos, "Sea island project - The Building of Islands in the Open Sea Offers Possibilities of Industrial Development," Westminster Dredging Group N.V., London, England, 1972.
- Keith, J.M., and Skjei, R.E., "Engineering and Ecological Evaluation of Artificial-Island Design, Rincon Island, Purita Gorda, California," Fort Belvoir, Virginia: Department of the Army, Coastal Engineering Research Center, Contract DACW72-73-C-0004, March 1974.
- Kerut, E., et al., "Advantages and Limitations Associated with Satellite Oceanographic Data Transmission Systems," NOAA Data Buoy Office, November 13, 1975.
- Kish, J., "The Law of International Spaces," Leiden, Netherlands: A.W. Sijthoff International Publishing Company, 1973.
- Kohl, J., (Ed.), "Energy from the Oceans Fact or Fantasy," Conference Proceedings, The Center for Marine and Coastal Studies, North Carolina State University, Report No. 76-1 UNC-SG-76-04, January 27-28, 1976.
- Komar, P.D., "The Mechanics of Sand Transport on Beaches," Journal of Geophysical Research, Vol. 76, No. 3, January 20, 1971.
- Konsigsberger, R.S., and Ribakoff, S.B., "Construction Site Selection," Hawaii's Floating City Development Program, Technical Report No. 6, Department of Ocean Engineering, University of Hawaii, UNIHI-SG-CR-74-04, 1974.

Langeveld, J.M., "Design Criteria for Single-Point Mooring Terminals," Journal of Waterways, Harbors, and Coastal Engineering Division, ASCE, Vol. 100, No. WW4, Proceeding Paper 10931, November 1974.

Lavi, A., (Ed.), Proceedings SOLAR SEA POWER PLANT CONFERENCE AND WORKSHOP, The National Science Foundation, (RANN) Division of Advanced Technology Applications, Washington, D.C., Carnegie-Mellon University, Pittsburg, Pennsylvania, June 27-28, 1973.

"Laws of the United States Relating to Water Pollution Control and Environmental Quality," U.S. House of Representatives, Washington, D.C.: Government Printing Office, 1970.

Lear, J., "Cities on the Sea?" Saturday Review, December 4, 1971, pp. 80-90.

Lehmann, E.J. (Ed.), "Thermal Pollution-Part 3, Hydrology and Hydrodynamics (A Bibliography with Abstracts)," NTIS/PS-76/0130, March 1976.

Leopold, L.B., et al., "A Procedure for Evaluating Environmental Impact," Geological Survey Circular 645, Washington, D.C.: U.S. Department of Interior, 1971.

Lerner, L., and Graham, M.A., "New York Offshore Airport Feasibility Study," System Research and Development Service, Washington, D.C., December 1974.

Lin, A.C.M., "A Feasibility Study of a Stable Mobile Ocean Platform as a Naval Base," Bethesda, Maryland: Systems Development Department, Naval Ship Research and Development Center, Report 3743, February 1973.

Liu, C., and Fashbaugh, R., "Wave Energy Extraction by Crescent Shaped Columns for Station Keeping of Floating Ocean Platforms-Hydraulic Model and Feasibility Study," Naval Civil Engineering Laboratory, TN N-1156, March 1971.

Lizarraga-Arciniega, J.R., and Komar, P.D., "Shoreline Changes due to Jetty Constructions on the Oregon Coast," Oregon State University, Sea Grant College Program, Publication No. ORESV-T-75-004, September 1975.

Logue, D.E., and Sweeney, R.J., "Issues in The Regulation of Deep Sea Mining: Will Rationality Prevail?" MTS Journal, Vol. 10, No. 3, April 1976, pp. 35-38.

"London's Third Airport: A Guide to the Sites," Aeroplane, Vol. 115, No. 2942, March 6, 1968, pp. 11-12.

"Long Beach Airport Looks to Sea," Engineering News-Record, Vol. 182, No. 8, February 20, 1969, pp. 34-35.

Lord, C.J., "Offshore Developments that Minimize Environmental Impact," Journal of the Construction Division, Vol. 100, No. 2, The American Society - P Civil Engineers, June 1974, pp. 159-170.

"Louisiana Superport Studies, Report No. 1, Preliminary Recommendations and Data Analysis," (Period January 1-June 15, 1972), Louisiana State University, August 1972.

Lowd, J.D., and Hill, E.C., "Use of a Spar Buoy Designed for Interim Production Processing," 1971 Offshore Technology Conference, Houston, Texas, Paper #OTC-1333.

Marcus, H.S., "The U.S. Superport Controversy," Technology Review, Vol. 75, No. 5, March/April 1973, pp. 49-57.

Mascenik, J., "Offshore Deepwater Crude-Oil Terminals," Esso Research and Engineering Company, Linden, New Jersey, 1973.

- May, A.E., et al., "Stable Floating Platform-Part I, Wave Breaking in Deep Water, Part II, Electromagnetic Roughness of the Ocean Surface, Part III," San Diego: University of California, August 13, 1973.
- Meier, R.L., "The Settlement of the Seas I: The Prospective Demands for Aquatic Surface," School of Natural Resources, University of Michigan, January 1964.
- Mercier, J.A., "A Method for Computing Float Platform Motion in Waves," Journal of Hydrodynamics, July 1970.
- Mero, J.L., "The Mineral Resources of the Sea," Amsterdam: Elsevier Publishing Company, 1965.
- "Miami's New Seaport Sits on Bayfill," Engineering News-Record, Vol. 174, No. 2, May 20, 1965, p. 23.
- Milgram, J.H., and Halkyard, J.E., "Wave Forces on Large Objects in the Sea," Journal of Ship Research, June 1971, pp. 115-124.
- Moore, S.F., "Offshore Oil Spills and the Marine Environment," Technology Review, February 1976, pp. 61-67.
- Morgan, R.G., "Concrete Floating and Submerged Structures," Concrete Society, London, 1973.
- Nath, J.H., "An Experimental Study of Wind Forces on Offshore Structures," Colorado State University, Fort Collins, August 1976.
- "National Shoreline Study: Regional Inventory Report - North Atlantic Region (2 Vols.), U.S. Army Corps of Engineers, 1971.
- "New Way to Sink Offshore Shafts," Ocean Industry, October 1972, p. 24.
- "New York Offshore Airport Feasibility Study," Vols. 2 and 3, Federal Aviation Administration, December 1974.
- Noone, J.A., "Energy Report/Oil Import Needs Versus Environmental Costs Key Issue in Deep Water Ports Legislation," National Journal Reports, Vol. 5, No. 45, November 10, 1973, p. 1665-1675.
- North Atlantic Deep Water Terminal, Ocean Industry, October 1972, p. 19.
- "Ocean Dumping: A National Policy," Washington, D.C.: Government Printing Office, October 1970.
- OCEAN 75-Conference, Proceedings, IEEE Publication 75 CHO 995-1, December 1975.
- "Offshore Airports - A Solution to the Airport Problem?" Civil Engineering, July 1967, p. 74.
- "Offshore Petroleum Transfer Systems for Washington State - A Feasibility Study," Seattle, Washington: Oceanographic Institute of Washington, December 16, 1974.
- "Offshore Platform Design," Materials Protection, Vol. 6, No. 1, January 1967, pp. 25-8.
- Offshore Power Systems, Design Report (in 6 Vols.), Atlantic City Nuclear Power Plant, Jacksonville, Florida, 1973.
- 1975 Offshore Technology Conference, Vols. I, II, and III, Proceeding from Conference, Houston, Texas, May 5-8, 1975.

- "Ohio Legislates for Lake Erie Airport," Engineering News-Record, Vol. 182, No. 8, February 20, 1969, p. 34.
- "Oil Islands, Glamorized," Petroleum Management, Vol. 39, No. 3, March 1967, p. 124.
- "Outer Continental Shelf Lands Act Amendments and Coastal Zone Management Act Amendments, Part 2," Washington, D.C.: U.S. Government Printing Office, 1975.
- "Outer Continental Shelf (OCS) Oil and Gas - An Environmental Assessment," Vols. I, II, III, IV, and V, Washington, D.C., The Council on Environmental Quality, April 1974.
- Outlaw, D.G., and Durham, D.L., "Lake Erie International Jetport Model Feasibility Investigation; Longshore Wave Energy Analysis," U.S. Army Engineer Waterways Experiment Station, Hydraulics Laboratory, Technical Report H-74-6, September 1975.
- Palmieri, T.M., "Strategic Storage, Superports and Salt Domes: A Synthesis," NTIS, 1974.
- Panicker, N.N., "Review of the Technology for Wave Power Conversion," MTS Journal, Vol. 10, No. 3, April 1976.
- Parsons, "Offshore Airport Planning," Federal Aviation Administration, Contract No. FA 69WA-2073, August 1969.
- Peraino, J., et al., "Features of Various Offshore Structures," Waterways Experimental Station, U.S. Army Corps of Engineers MP-3-75, 1975.
- Peraino, Joseph, "Two Tunnels and Four Islands-Chesapeake Bay Bridge - Tunnel Project," Civil Engineering, December 1963, pp. 47-49.
- Pikarsky, Milton, and Corey, John B.W., "An Airport in Lake Michigan," Civil Engineering, September 1968, pp. 52-54.
- Pizzo, J.T., "The Application of Systems Analysis Techniques to Social Impacts Due to Oil Spilled in the Marine Environment," Renssalaerville, New York, September 1973.
- Porricelli, Joseph D., et al., "Tankers and the Ecology," Proceedings, Society of Naval Architects and Marine Engineers, New York, New York, November 1971.
- Porricelli, Joseph D., and Keith, Virgil, Tankers and the Energy situation-An Economic and Environmental Analysis, Vol. 2, September 1973.
- "Port Development in the United States," Washington, D.C.: National Research Council, National Academy of Science, 1976.
- "Port of Oakland Develops Offshore Marine Terminal," Engineering News-Record, Vol. 181, No. 12, September 19, 1968, p. 91.
- Power, Harry H., "Holland Pushes Back the Sea," Civil Engineering, December 1958, pp. 58-61.
- Prescott, J.H., "Supership Era Ahead?" Chemical Engineering, February 19, 1973, pp. 56-57.
- "Primary Physical Impacts of Offshore Petroleum Developments," Massachusetts Institute of Technology, Report No. MITSG 74-20, 1974.
- Proceedings: Joint Conference on Prevention and Control of Oil Spills, American Petroleum Institute, 1970.

- Richards, A.F., "Extracting Energy for the Oceans: A Review," Marine Technology Society Journal, Vol. 12, No. 2, February-March 1976.
- "Rotterdam Expands Riverfront with Stone and North Sea Sand," Engineering News-Record, Vol. 179, No. 18, November 2, 1967, pp. 26-27.
- Rounsefell, G.A., Ecological Effects of Offshore Construction, Marine Science Institute, Bayou La Batre, Alabama, Journal of Marine Science, Vol. 2, No. 1, 1972.
- "Running Out of Land, Build At Sea," Engineering News-Record, Vol. 178, No. 16, April 18, 1967, p. 31.
- Sallenger, A.H., Jr., Goldsmith, V., and Sutton C.H., "Bathymetric Comparisons: A Manual of Methodology, Error Criteria and Techniques," Special Report No. 66, Applied Marine Science and Ocean Engineering, Virginia Institute of Marine Science, Gloucester Point, Virginia, July 1975.
- "San Francisco Floating STOLport Study," San Francisco, California: NORCALSTOL, Greater San Francisco Chamber of Commerce, February 28, 1974.
- Schumeir, C.P., Gezen, A., and Kendrick, M., "Economic Aspects of Refinery and Deep-Water Port Location in the United States," Final Research Report, Vols. 1, 2, 3, and 4, U.S. Department of Transportation, Office of Assistant Secretary for Policy, Plans and International Affairs, PB 236-701, May 1974.
- "Sea City, A Project for the Year 2120," The Engineer, Vol. 225, No. 5850, March 8, 1968, p. 395.
- "Selected U.S. Laws Applying to Offshore Structures and Uses," Oceanus, Fall 1975.
- Shapley, D., "Sea Law Treaty: Amid U.S. Gains, the Prospects for Science are Sinking," Science, Vol. 192, June 1976, pp. 980-981.
- Shaw, S.H., "New Anchoring Concept Moors Floating Drydock," Ocean Industry, January 19/2, pp. 31-33.
- Sheets, H.E., "Power Generation from Ocean Currents," Naval Engineering Journal, April 1975.
- "Shore Protection, Planning and Design," TR-4, 3rd ed., Washington, D.C.: U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1966.
- Shoupp, W.E., Devanney, J.W., III, and Harleman, D.R., Massachusetts Institute of Technology Second Annual Sea Grant Lecture and Symposium: World Energy and the Oceans, Key Issues in Offshore Oil and Innovations in Heat Disposal in the Oceans, MIT, Cambridge, Massachusetts, Report No. MITSG 74-7, October 1973.
- Sier, Arne, and Fasullo, Eugene J., "La Guardia Runways Extended Over Water," Civil Engineering, August 1966, pp. 32-37.
- Silverstein, A., "A New Approach to the Cleveland/Northeastern Ohio Region - the Lake Erie International Jetport Project," Greater Cleveland Growth Association, March 1971.
- Smethers, R.G., Jr., "Amphibian STOL and its Facilities," Paper, Air Transportation Meeting, Dallas, Texas, Society of Automotive Engineers, 740488, April 30-May 2, 1974.
- Smith, F.A., et al., Fourteen Selected Marine Resources Problems of Long Island, New York: Descriptive Evaluations, Hartford, Connecticut: The Travelers Research Corporation, January 1970.

- Spiess, F.N., "Advanced Marine Technology: Stable Floating Project," Office of Naval Research, Contract N00014-69-A-0200-6012, May 1974.
- Spilhaus, A., "Bountiful Grants of the Sea," First Annual Sea Grant Lecture, MIT Sea Grant Program, Massachusetts Institute of Technology, Report No. MITSG 73-1, Index No. 73-901-Weo, September 27, 1972.
- Spilhaus, A., et al., "Experiments in Excellence: A Report of the Conference on Seaward Advancement of Industrial Society," MTS Journal, Vol. 9, No. 3, March 1975, pp. 5-28.
- Sooms, A.H.A., "Artificial Islands and Installations in International Law," Law of the Sea Institute, Occasional Paper #22, University of Rhode Island, July 1974.
- St. Denis, M., "The Winds, Currents and Waves at the Site of the Floating City Off Waikiki," Technical Report No. 1, NOAA, Office of Sea Grant, Department of Commerce Grant No. 04-5-158-17, Department of Ocean Engineering, University of Hawaii, December 1974.
- Stone, J.H., "Louisiana Super Port Studies," Report 2, Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana, 1972.
- "A Study of A Prototype Floating Community," Department of Housing and Urban Development, PB 180051, November 1968.
- "Superport Environmental Protection Plan," Deep Draft Harbor and Terminal Authority, Louisiana Board of Commissioners, January 15, 1974.
- "Survey of Unique Technical Features of the Floating Nuclear Power Plant Concept," Washington, D.C.: U.S. AEC, Directorate of Licensing, March 1974.
- "Sydney's Airport Reaches Over the Water to Greet Jumbo Jets," Engineering News-Record, Vol. 182, No. 9, February 27, 1969, pp. 26-27.
- Taler, J.S., "Offshore Petroleum Installations," Proceedings ASCE, Vol. 79, No. 289, 1953.
- Talkington, H.R., "The Floating Stable Platform: Transferring Navy Technology to Civilian Application," San Diego: Naval Under Sea Center, December 1972.
- "Technical Feasibility of Floating Interim Manhattan Stolport," Washington, D.C.: Federal Aviation Administration, Contract DOT-FA70WA-2411, September 1970.
- Thompson, E.F., and Harris, D.L., "A Wave Climatology for U.S. Coastal Waters," U.S. Army, Corps of Engineers, Coastal Engineering Research Center, May 1972.
- Timpson, James, "Practicality and Potential of Offshore Artificial Island Shipping Terminals," Preprints, 7th Annual Marine Technology Society Conference, Washington, D.C., August 1971.
- "Toward Fulfillment of a National Ocean Commitment," Washington, D.C.: Marine Board, National Academy of Engineering, 1972.
- Turner, J.E., "Manufacturing Plans, Concepts and Facilities for Floating Nuclear Plants," Nuclear Engineering International, Vol. 18, No. 205, June 1973.
- "United States Petroleum Through 1990," Cities Service Company, Washington, D.C., June 1971.
- "Virginia and the Outer Continental Shelf: Problems, Possibilities and Posture," Richmond, Virginia: Commonwealth of Virginia, Council on the Environment, November 7, 1974.

- "Washington Has New Floating Bridge," Civil Engineering, November 1963, p. 92.
- Wenk, E., Jr., "The Policies of the Ocean," Seattle: University of Washington Press, 1976.
- "West Coast Deepwater Port Facilities Study," U.S. Army Corps of Engineers, June 1973.
- Wheby, F.T., "Offshore Airport Site Planning," Transportation Engineering Journal, August 1974, pp. 543-551.
- Wiegel, R.L., Oceanographical Engineering, Englewood Cliffs, New Jersey: Prentice-Hall, 1964.
- Wood, E.D., Youngbluth, M.J., and Yoshioka, P., "Cabo Rojo Platform Environmental Studies," Nuclear Center of the University of Puerto Rico, PRNC-187, May 15, 1975.
- Woodward - Clyde, "Mid-Atlantic Regional Study: An Assessment of the Onshore Effects of Offshore Oil and Gas Development," (Executive Summary), Woodward - Clyde Consultants, October 1975.
- "World's Largest Sea-Going Passenger Hydrofoils for Offshore Island Services," Matar Ship, Vol. 52, No. 610, May 1971, pp. 67-68.
- Yee, A.A., et al., "Design and Construction of Oceangoing Pretensioned Concrete Barges," ACI Journal, Vol. 72, No. 4, April 1975.
- Yumori, I.R., Structural Siting of Flotation Modules and Construction Barge, Department of Ocean Engineering, University of Hawaii, UNIHI-SEAGRANT-CR-74-03, March 1974.
- Zener, C., "Solar Sea Power," Physics Today, January 1973, pp. 48-53.
- "The Zuyder Zee Works," 8th Edition, Edited by the Information Department of the Ministry of Transport, Water Control and Public Works, Hague, Netherlands, 1967.

APPENDICES

APPENDIX A

FACULTY FELLOWS AND ASSOCIATES NASA-ASEE ENGINEERING SYSTEMS DESIGN PROGRAM SUMMER 1976

Project Director:

Michael Z. Sincoff
B.A., M.A. University of Maryland
Ph.D., Purdue University
Area of Expertise: Interpersonal/Organizational Communication
Associate Professor of Interpersonal Communication
and Director, Center for Communication Studies
Ohio University
Athens, Ohio

Assistant Project Director:

Jarir S. Dajani
B. Eng., American University of Beirut
M.Sc., Stanford University
Ph.D., Northwestern University
Area of Expertise: Transportation and Public Systems Planning
Associate Professor of Civil Engineering
Department of Civil Engineering
Stanford University
Stanford, California

Participants:

Lawrence S. Beckhouse
B.A., Knox College
M.A., Ph.D., Vanderbilt University
Area of Expertise: Sociology
Associate Professor of Sociology
Department of Sociology
College of William and Mary
Williamsburg, Virginia

Theodore M. Breu
B.A., St. Mary's College
M.S., Purdue University
Ph.D., Southern Illinois University
Area of Expertise: Management Science
Associate Professor of Management Science
Department of Business Administration
University of Minnesota, Duluth
Duluth, Minnesota

Eugene Chesson, Jr.
B.S.C.E., Duke University
M.S., Ph.D., University of Illinois
Area of Expertise: Civil Engineering
Professor of Civil Engineering
Department of Civil Engineering
University of Delaware
Newark, Delaware

Peter Cornillon
B.S., Ph.D., Cornell University
Area of Expertise: Physics, Ocean Engineering, Digital Processing
Assistant Professor of Physics
Department of Ocean Engineering
University of Rhode Island
Kingston, Rhode Island

Joseph E. Dandois
B.S.Ed., Mansfield State College
B.S.E.E., M.S.E.E., Ph.D., Pennsylvania State University
Area of Expertise: Electrical Engineering
Associate Professor of General Engineering
Department of General Engineering
Pennsylvania State University, Hazleton
Hazleton, Pennsylvania

Alvin James Darby
B.A., Linfield College
M.S., Ph.D., Howard University
Area of Expertise: Molecular Physics, Engineering
Department of Engineering and Computer Science
University of the District of Columbia
Washington, D.C.

Les Frair
B.S., University of Tulsa
M.E.A., University of Utah
Ph.D., University of Oklahoma
Area of Expertise: Operations Research
Assistant Professor of Industrial Engineering and Operations Research
Department of Industrial Engineering and Operations Research
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

Michael Fulda
M.A., Ph.D., American University
Area of Expertise: International Relations, Energy Policy
Associate Professor of Political Science
Department of Political Science
Fairmont State College
Fairmont, West Virginia

Serge Gonzales

A.B., Duke University

M.S., Miami (Ohio) University

Ph.D., Cornell University

Area of Expertise: Environmental and Mineral Resource Geology

Assistant Professor of Geology and Staff Institute Geologist

Department of Geology and Institute of Community and Area Development

University of Georgia

Athens, Georgia

Abe Kellizy

B.S., Washington State University

M.S., Oklahoma State University

Ph.D., Clemson University

Area of Expertise: Operations Research, Chemical Engineering, Economics

Assistant Professor of Business Administration

School of Business and Public Administration

Howard University

Washington, D.C.

Michael Kyong-il Kim

B.S., Seoul National University

M.Arch., Ohio State University

Ph.D. (in progress), University of California, Berkeley

Area of Expertise: Architecture, Planning

Associate in Architecture

Department of Architecture

University of California, Berkeley

Berkeley, California

Jeffrey A. King

B.S., New York University

J.D. (in progress), University of Wyoming

Area of Expertise: Taxation

Law Student

University of Wyoming

Laramie, Wyoming

Joseph H. Marchal

B.A., M.A., Michigan State University

Ph.D., Washington University

Area of Expertise: Philosophy of Science

Assistant Professor of Philosophy

University of Missouri, Rolla

Rolla, Missouri

Stephen J. Mecca

B.S., M.S., Providence College

Ph.D., Rensselaer Polytechnic Institute

Area of Expertise: Systems Analysis, Physics

Associate Professor of Physics and Director, Engineering Program

Department of Physics
Providence College
Providence, Rhode Island

Blake D. Morant
B.A., J.D.(in progress), University of Virginia
Area of Expertise: Administrative and Environmental Law
Law Student
University of Virginia
Charlottesville, Virginia

Vjekoslav Pavelic
Dipl.Eng., State University, Zagreb
M.S., Ph.D., University of Wisconsin, Madison
Area of Expertise: Mechanical Engineering
Associate Professor of Systems Design
Department of Systems Design
University of Wisconsin, Milwaukee
Milwaukee, Wisconsin

Newton Rose
B.S., City College of the City University of New York
M.S., Pennsylvania State University
Ph.D., Columbia University
Area of Expertise: Geography, Economic Development
Assistant Professor of Political Science-Geography
Department of Political Science-Geography
Old Dominion University
Norfolk, Virginia

Jay R. Sculley
B.S., Virginia Military Institute
M.S.E., Ph.D., John Hopkins University
Area of Expertise: Environmental Engineering, Operations Research
Associate Professor of Civil Engineering
Department of Civil Engineering
Virginia Military Institute
Lexington, Virginia

Harvey B. Silverstein
B.A., University of Wisconsin
M.A., Ph.D., University of Denver
Area of Expertise: Science, Technology, and International Affairs
Assistant Professor of International Studies
Department of Government and International Studies
University of South Carolina
Columbia, South Carolina

Donald E. Todd
B.S., M.S., Ph.D., Texas A&M University
Area of Expertise: Electrical Engineering
Associate Professor of Electrical Engineering
Department of Electrical Engineering
Texas A&I University
Kingsville, Texas

Illustrator:

John F. Kehoe
B.S. (in progress), Old Dominion University
Civil Engineering

Secretarial Staff:

Marsha S. Davenport
B.S. (in progress), Old Dominion University
Business Education

Reba Hudspeth
Pembroke High School

Loretta L. Powers
B.S. (in progress), Old Dominion University
Business Education

Sandy E. Sealey
B.S. (in progress), Old Dominion University
Business Education

APPENDIX B

GUEST LECTURERS

<u>Date</u>	<u>Speaker/Affiliation/Topic</u>
June 7	Dr. Wayne D. Erickson NASA-Langley Research Center "Overview of Offshore Island Complexes"
June 8	Mr. Vincent R. Maschitti NASA-Langley Research Center "Supersonic Cruise Aircraft"
June 10	Mr. John P. Mugler, Jr. NASA-Langley Research Center "Marine Environment and Remote Sensing Technology"
June 10	Dr. Victor Goldsmith Virginia Institute of Marine Sciences "Shoreline Waves--Another Energy Crisis"
June 14	Mr. Cornelius Driver NASA-Langley Research Center "Short-Haul Ground-Effect Seaplanes"
June 18	Mr. D. William Conner NASA-Langley Research Center "Short-Haul Transportation To and From An Island"
June 21	Mr. Gerald McCarthy Virginia Council on the Environment "Regulatory and Environmental Issues in Ocean Development"
June 22	Dr. Paul D. Cribbins North Carolina State University "Offshore Island Industrial Complexes"
June 28	Mr. Eugene Harlow Frederick R. Harris, Associates "Deepwater Ports"
July 1	Mr. Robert D. Witcofski NASA-Langley Research Center "Hydrogen"
July 1	Dr. Gordon Dugger Johns Hopkins University Applied Physics Laboratory "Offshore Thermal Energy Conversion"

<u>Date</u>	<u>Speaker/Affiliation/Topic</u>
July 6	Dr. Anthony Provenzano Old Dominion University "Mariculture"
July 13	Mr. David P. Maniago Offshore Power Systems "Offshore Nuclear Power Systems"
July 15	Major Henry G. Shirley United States Air Force "Environmental Impact Statements"
July 28	Dr. Kurt Finsterbusch University of Maryland "Social Impact Assessment"

APPENDIX C
ACKNOWLEDGEMENTS

Appreciation is expressed to the following persons and organizations for providing material, information, and assistance. These individuals and organizations are not responsible for any inconsistencies or reportorial errors that might be found in this document.

<u>Name</u>	<u>Organization / City</u>
Roger Anderson	Virginia Institute of Marine Science Gloucester Point, Virginia
Johannes G. Augustinus	The Port of Authority of New York and New Jersey New York, New York
Nadine Badkin	NASA-Langley Research Center Hampton, Virginia
Wesley Berryman	NASA-Langley Research Center Hampton, Virginia
Sandra Blow	NASA-Langley Research Center Hampton, Virginia
Frank A. Clark	The Register and Tribune Syndicate Des Moines, Iowa
Joseph F. Coates	Office of Technology Assessment Washington, D.C.
Dennis Conlon	Office of Naval Research Arlington, Virginia
C. William Conrad	Newport News Shipbuilding and Dry Dock Company Newport News, Virginia
F. Joseph Dandois	Virginia Port Authority Norfolk, Virginia
James Daus	NASA-Langley Research Center Hampton, Virginia

Asem M. Elgawhary	Bechtel Power Corporation Gaithersburg, Maryland
James Gray	Division of Aeronautics Richmond, Virginia
Robert Halsey	Monmouth County Planning Board Freehold, New Jersey
Jane Hess	NASA-Langley Research Center Hampton, Virginia
James W. Hines	Federal Aviation Administration Washington, D. C.
Robert M. Hordon	Rutgers University New Brunswick, New Jersey
George P. Howard	The Port Authority of New York and New Jersey New York, New York
Kathi Jensen	University of Delaware Newark, Delaware
R. H. Knapp	Boeing Marine Systems Seattle, Washington
Paul Larson	Federal Aviation Administration Washington, D. C.
Leigh Lawrence	Virginia Institute of Marine Science Gloucester Point, Virginia
David P. Maniago	Offshore Power Systems Jacksonville, Florida
Ernest E. Melvin	University of Georgia Athens, Georgia
James Modarelli	NASA-Lewis Research Center Cleveland, Ohio
Augustus Nasmith	National Academy of Science Washington, D. C.
Charles H. Nelson	Virginia Port Authority Norfolk, Virginia
Robert E. Noziglia	Division of Aeronautics Richmond, Virginia

Thomas Pinelli	NASA-Langley Research Center Hampton, Virginia
Maj. Henry G. Shirley	Langley Air Force Base Hampton, Virginia
Abe Silverstein	Republic Steel Corporation Cleveland, Ohio
Michael Swinford	Newport News Shipbuildin and Dry Dock New Port News, Virginia
Wayne K. Talley	Old Dominion University Norfolk, Virginia
Marie Tuttle	NASA-Langley Research Center Hampton, Virginia
Jane Wagenfeld	NASA-Langley Research Center Hampton, Virginia
Katherine Walker	Board of Education Newport News, Virginia
C. Wayne Williams	NASA-Langley Research Center Hampton, Virginia
Kenneth R. Williams	Ohio University Athens, Ohio
Robert Witcofsky	NASA-Langley Research Center Hampton, Virginia

APPENDIX D

ORGANIZATION OF THE DESIGN TEAM

A. Preliminary Study

To attain the goals of the project within an eleven-week period, the design study was organized into various phases. Initially, participants were divided into four basic groups for preliminary study:

Group A (Uses):

J.R. Sculley, Chairman
T.M. Breu
J.E. Dandois
L. Frair
S.J. Mecca
H.B. Silverstein
D.E. Todd

Group B (Environment):

N. Rose, Chairman
L.S. Beckhouse
A.J. Darby
A. Kellizy
M.K. Kim
B.D. Morant

Group C (Structures):

E. Chesson, Jr., Chairman
P. Cornillon
J.F. Kehoe
V. Pavelic

Group D (Institutions):

M. Fulda, Chairman
S. Gonzales
J.A. King
J.H. Marchal

B. Group Assignments

Following four weeks of preliminary investigation, the design team was redivided into five groups in order to perform a planning and evaluation analysis during weeks five through nine:

Group I (Functions): S.J. Mecca, Chairman; E. Chesson, Jr.; P. Cornillon; L. Frair; M.K. Kim

Group II (Physical Design): E. Chesson, Jr., Chairman; J.F. Kehoe; M.K. Kim; S.J. Mecca; V. Pavelic; D.E. Todd

Group III (Socio-Economic): L. Frair, Chairman; L.S. Beckhouse; T.M. Breu; J.H. Marchal; N. Rose; J.R. Sculley; H.B. Silverstein

Group IV (Physical-Ecological): S. Gonzales, Chairman; P. Cornillon; A.J. Darby; B.D. Morant

Group V (Legal-Political): J.A. King, Chairman; J.E. Dandois; M. Fulda; A. Kellizy

C. During the final five weeks of the study, two additional committees were formed:

Oral Presentation Committee:

E. Chesson
A. J. Darby
A. Kellizy
S. J. Mecca
B. D. Morant
J. R. Sculley
H. B. Silverstein

Editorial Committee:

M. Z. Sincoff
J. S. Dajani

APPENDIX E
SELECTED CONVERSION FACTORS
To S.I. (Metric)

<u>Length</u>	in = 25.40000 mm ft = 0.30480 m mile = 1.60934 km nautical mile = 1.85200 km
<u>Area</u>	in ² = 645.16000 mm ² ft ² = 0.09290 m ² acre = 0.40469 hm ² mile ² = 2.58999 km ²
<u>Volume</u>	in ³ = 16387.06400 mm ³ ft ³ = 0.02832 m ³ U.S. gal (liquid) = 3.78541 litre
<u>Mass</u>	1b = 0.45359 kg short ton = 0.90718 Mg long ton = 1.01605 Mg
<u>Force</u>	1bf = 4.44822 N
<u>Pressure</u>	psi = 6.89476 kPa
<u>Power</u>	Btu/h = 0.29307 W hp = 0.74600 kW
<u>Energy</u>	Btu = 1.05506 kJ kW·h = 3.60000 MJ
<u>Prefixes</u>	M mega 10^6 k kilo 10^3 h hecta 10^2 m milli 10^{-3}